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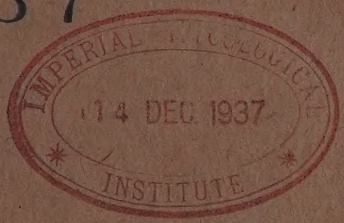

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MATHÉMATIQUES

Par N. VEDENISOV (VEDENISSOFF)

SUR LES VARIÉTÉS DE E. ČECH

(Présenté par S. N. Bernstein, de l'Académie, le 3. VIII. 1937)

1. P. Alexandroff [(1), problème IV'] a posé la question: existe-t-il des variétés fermées au sens de E. Čech [(2) et (3)] non métrisables? On peut juger des difficultés que nous présente ce problème d'après son rapport, établi dans cette note, au problème connu de M. Souslin, concernant les ensembles ordonnés (Fund. Math., I, 233). En appelant l'ensemble S un ensemble ordonné qui est α) continu, β) borné, γ) tel que toute famille d'intervalles non empiétants de cet ensemble est au plus dénombrable, le problème de Souslin peut être formulé comme il suit: démontrer que tout ensemble S est semblable à un segment de nombres réels.

Théorème. *Dans le cas, et dans ce cas seulement, où le problème de Souslin possède une solution affirmative, toutes les variétés fermées de Čech de dimension 1* [(les V_0^1 (0) dans sa notation, (2), III, 7] *sont des espaces topologiques métrisables.*

Appelons ensemble T un ensemble ordonné d'une façon cyclique qu'on obtient en identifiant les deux extrémités d'un ensemble S. Le théorème énoncé est contenu dans les propositions suivantes, dont la seconde est intéressante en soi.

I. *Un ensemble T est une V_0^1 (0).*

II. *V_0^1 (0) est une réunion d'un nombre fini d'ensembles T extérieurs les uns aux autres.*

I et II seront respectivement demontrées dans les n°n° 2 et 3.

2. Par sa définition V_0^1 (0) [(3), III, 7] est un espace de Hausdorff R qui possède les propriétés suivantes: 1) R est bicompact; 2) tout ensemble ouvert dans R est un F_σ; 3) $\dim R = 1$ [la dimension est à comprendre au sens de E. Čech, (2), 2.2]; 4) R est localement connexe d'ordre 1 relativement à chaque point $x \in R$; 5) $\beta_1(x, R) = 1$ pour chaque point $x \in R$ (3); 6) A étant un sous-ensemble fermé de R, on a $\beta_1(x, A) = 0$ pour chaque point $x \in A\ \overline{R - A}$.

Soit R un ensemble T. La propriété 1) est vérifiée car tout ensemble ordonné, continu et borné, est bicompact [(5), 251]. 2) est contenue dans le lemme:

Tout sous-ensemble ouvert G d'un ensemble S est un F_σ.

Démonstration. G est une réunion au plus dénombrable d'intervalles non empiétants; il suffit donc de prouver qu'un intervalle $I = (x, y)$ de R est un F_σ. Or il est connu [(5), 191] qu'il existe une suite

croissante bien ordonnée convergeant vers y dont le type d'ordre est un nombre transfini régulier ω_α. D'après la propriété γ) des ensembles S, on a $\omega_\alpha = \omega_0 = \omega$; donc y est la limite d'une suite croissante $y_i (i < \omega)$. De même x est la limite d'une suite décroissante $x_i (i < \omega,\ x < x_i \leqslant x_1 < y_1)$. Puisque $I = \mathfrak{S}_i [x_i, y_i]$, le lemme est démontré.

Appelons maintenant irréductible un réseau [=recouvrement fini, ([4]), II, 1] de R, dont les sommets sont des intervalles et tel qu'il cesse d'être un recouvrement, lorsqu'on éloigne un de ses sommets n'importe lequel. Chaque réseau $\mathfrak{G} = \{G_1, \ldots, G_n\}$ possède un affinement [([4]), II, 30] irréductible. En effet, si l'on a $G_i = \mathfrak{S}_{k=1}^{\infty} I_k^i$ $(i = 1, 2, \ldots, n)$, les I_k^i $(k = 1, 2, \ldots)$ étant des intervalles non empiétants, l'ensemble de tous les I_k^i $(i = 1, 2, \ldots, n;\ k = 1, 2, \ldots)$ est un recouvrement; selon 1) on peut en extraire un réseau; celui-ci contient évidemment un réseau irréductible. Il s'en suit que la famille des réseaux irreductibles est une famille complète [([4]), II, 30]. Il est évident qu'on peut ordonner d'une façon cyclique les intervalles du réseau irréductible de manière que les intervalles voisins (dans cet ordre), et seulement ces intervalles voisins, ont des points communs. Soit $\mathfrak{J} = \{I_1, \ldots, I_n\}$, $I_n = I_1$, un réseau irréductible ordonné de cette façon. Désignons par S_k^1 le $(1, \mathfrak{J})$-simplexe (I_k, I_{k+1}) et posons $C^1(\mathfrak{J}) = \sum_1^{n-1} S_k^1$. $C^1(\mathfrak{J})$ est un $(1, \mathfrak{J})$-cycle absolu. Il est facile de voir que $\mathfrak{J}'$ étant un affinement irréductible de $\mathfrak{J}$ et $\pi = \Pr(\mathfrak{J}', \mathfrak{J})$ étant une projection de $\mathfrak{J}'$ dans $\mathfrak{J}$, on a $\pi C^1(\mathfrak{J}') = C^1(\mathfrak{J})$, d'où il s'en suit [([4]), II, 30] que $\{C^1(\mathfrak{J})\}$ définit un $(1, R)$-cycle absolu C^1. On montre sans peine que pour tout $(1, R)$-cycle absolu Γ^1 on a $\Gamma^1 = rC^1$, donc le premier nombre de Betti $p_1(R)$ est égal à l'unité. On en conclut que 4) est vérifiée.

On voit facilement que chaque $(1, R)$-cycle mod $R - U, U = U(x) \neq R$ étant un voisinage connexe du point x (un intervalle), est égal modulo $R - U$ à un des cycles rC^1, ce qui entraîne 5).

Enfin on vérifie 6) comme il suit: un cycle D^1 mod $A - U$ est à fortiori un cycle mod $R - U$, donc on a $D^1 = rC^1 \bmod R - U$. Soit $x \in A\overline{R - A}$; A étant fermé, U contient un intervalle J tel que $JA = 0$. Soit $\mathfrak{J}$ un réseau irréductible tel que le noyau [([4]), II, 2] d'un au moins de ses simplexes S_k^1 est contenu dans J. Alors S_k^1 n'est pas contenu dans A, donc $r \neq 0$, $D^1 = 0$.

3. Soit R une $V_0^1(0)$. L'espace R est localement connexe [([2]), 65, 1], donc les composantes de R sont des ensembles ouverts non empiétants et recouvrant R, d'où il s'en suit qu'ils sont en nombre fini. Les composantes de R sont des $V_0^1(0)$. Tout d'abord, elles sont bicompactes (puisqu'elles sont des ensembles fermés de R). 2) est vérifiée pour tout sous-ensemble de R. Étant connexe et ne pouvant pas se réduire à un point en vertu de la propriété 4) de l'espace R, une composante est de dimension 1.

Enfin les propriétés 4), 5), 6), sont remplies pour chaque composante parce qu'elles sont locales.

Nous pouvons donc supposer que R est connexe.

L'indice de ramification au sens d'Urysohn-Menger est supérieur à 1 dans tout point de R. En effet, si $\operatorname{ind}_x R \leqslant 1$, il existe un voisinage $U = U(x)$ dont la frontière se reduit à un point (ou bien est vide) et tel que $\beta_1(x, U, R) = 1$ [([3]), I, 1].

Soit $C^1 = \{C^1(\mathfrak{G})\}$ un $(1, R)$-cycle mod $R - U$ qui n'est pas égal à zéro mod $R - U$. Il est aisé de voir qu'il existe alors un réseau $\mathfrak{G}$ d'ordre 2 tel que les conditions suivantes se trouvent vérifiées: $C^1(\mathfrak{G}) \neq 0 \bmod R - U$; on a pour chaque sommet G du réseau $\mathfrak{G}$, sauf peut-être pour un seul, une des deux relations $G\overline{U} = 0$, $G(R - U) = 0$. Or, $\mathfrak{G}'$ étant un affinement de $\mathfrak{G}$ normal respectivement aux $(1, \mathfrak{G})$-cycles mod $R - U$ [(4), II, 15], le cycle $\pi C^1(\mathfrak{G}') = C^1(\mathfrak{G}) \neq 0$ est un $(1, \mathfrak{G})$-cycle absolu essentiel [(4), II, 14], ce qui est, selon (4), II, 28, en contradiction avec 4.

Soit U un voisinage suffisamment petit connexe du point x et a, b—deux points de sa frontière $\overline{U} - U$. En tenant compte de la connexité de U pour le $(0, R)$-cycle $\Gamma^0 = \{a\} - \{b\}$ [(4), II, 14] on a $\Gamma^0 \sim 0$ dans $\bar{U}$.

Soit H porteur de l'homologie $\Gamma^0 \sim 0$ [(2), 10, 3]. En désignant par A l'ensemble composé de deux point a, b, l'ensemble $H - A$ est ouvert dans R [(2), II ou (3), 9, 11]. On a $U = H - A$, car dans le cas contraire $U = (H - A) + [U - (H - A)]$ est une décomposition de U en deux sous-ensembles ouverts dans U. Il s'en suit que $\overline{U} - U = \overline{H - A} - (H - A) = A$, la frontière de U se réduit donc à deux points. Donc pour tout point $x \in R$ on a $\operatorname{ind}_x R = 2$. Or il est connu (6) qu'un espace de Hausdorff connexe dont tous les points sont d'indice 2 est cycliquement ordonné.

Enfin les propriétés 1), 2) entraînent [(7), II, 12] qu'un système d'ensembles ouverts dans R non empiétants est au plus dénombrable. Donc R est un ensemble T.

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LITTÉRATURE CITÉE

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ASTRONOMIE

RETOUR AU PÉRIHÉLIE DE LA COMÈTE PÉRIODIQUE DE NEUJMIN II EN 1937

Par G. N. NEUJMIN

(Présenté par V. G. Fessenkov, de l'Académie, le 21. VII. 1937).

Le retour au périhélie de la comète de Neujmin II qui aura lieu au mois de novembre 1937 doit achever les quatre tours accomplis par cet astre depuis sa découverte en 1916. Le calcul de sa future apparition etait fait à la base des éléments de l'orbite appartenant à cette comète et déduits de la relation entre ses deux apparitions observées en 1916 et en 1926/7.

Une communication préliminaire sur ces éléments a été publiée dans les Comptes Rendus de l'Académie des Sciences de l'URSS, v. XV, No 4, 1937.

Partant de ces éléments, nous avons calculé les perturbations approximatives des éléments de la comète, provenant de Jupiter et de Saturne depuis le 4 mars 1927 jusqu'au 26 novembre 1937.

Ces perturbations sont:

$\Delta M_0 + 0°.797$	$\Delta i \; -0°.005$
$\Delta\omega \; -0\,.056$	$\Delta\varphi \; -0\,.015$
$\Delta\Omega \; -0\,.021$	$\Delta n \; -0°.000022$

Pour prendre en considération l'influence des quatre planètes intérieures nous avons ajouté leurs masses à celle du Soleil ce qui a changé la valeur de la constante de gravité de Gauss (k=0.01720215) et augmenté conformément le mouvement diurne moyen.

Il en résulta le système d'éléments qui suit:

Époque et osculation: 1937, 26.XI, 0 heures d'après le temps universel

	M_0	0°.8623	
1925.0	ω	193.679	Log a 0.48988.
	Ω	327.624	Passage par le périhélie 1937, 21. XI, 249
	i	10.624	
	φ	34.514	
	n	0°.181502	

$$1925.0 \quad \begin{cases} x' = r\,[9.9979]\sin(251°.749 + v) \\ y' = r\,[9.9271]\sin(158.157 + v) \\ z' = r\,[9.7348]\sin(170.575 + v) \end{cases}$$

Les éphémérides suivantes de la comète reduites pour 1937. 0 furent calculées directement d'après ces éléments.

Outre les logarithmes du rayon-vecteur et de la distance géocentrique de la comète nous donnons aussi les logarithmes de la valeur $r^4\Delta^2$ qui caractérisent suffisamment les changements de l'éclat de la comète.

Éphémérides de la comète

Date 0^h temps univers.	Position 1937.0		Log r	Log Δ	Log $r^4\Delta^2$	Grandeur stellaire	Variations
Oct. 10	$10^h35^m.9$	$+11°23'$	0.152	0.308	1.224	16^m	—10′.1
	12.3	96					
14	10 48 .2	+ 9 47					
	12.2	98					
18	11 0 .4	+ 8 9	0.144	0.297	1.170		
	12.3	100					
22	11 12 .7	+ 6 29					
	12.2	102					
26	11 24 .9	+ 4 47	0.137	0.287	1.122		
	12.3	105					
30	11 37 .2	+ 3 2					
	12.2	107					
Nov. 3	11 49 .4	+ 1 15	0.132	0.278	1.104		
	12.2	107					
7	12 1 .6	— 0 32					
	12.2	106					
11	12 13 .8	— 2 18	0.128	0.271	1.054		
	12.2	106					
15	12 26 .0	— 4 4					
	12.2	106					
19	12 38 .2	— 5 50	0.127	0.264	1.036	15^m	— 9′ 9
	12.2	105					
23	12 50 .4	— 7 35					
	12.2	104					
27	13 2 .6	— 9 19	0.127	0.258	1.024		
	12.2	102					
Déc. 1	13 14 .8	—11 1					
	12.1	100					
5	13 26 .9	—12 41	0.130	0.254	1.028		
	12.2	97					
9	13 39 .1	—14 18					
	12.2	94					
13	13 51 .3	—15 52	0.134	0.251	1.038		
	12.2	91					
17	14 3 .5	—17 23					
	12.2	88					
21	14 15 .7	—18 51	0.140	0.248	1.056		
	12.1	84					
25	14 27 .8	—20 15					
	12.0	80					
29	14 39 .8	—21 35	0.147	0.245	1.078	15^m	— 6′.7

Nous voyons que près du périhélie la comète peut être observée de la Terre, mais les conditions d'observation ne peuvent être évaluées comme favorables. D'une part la distance séparant la comète de la Terre reste toujours importante—un peu moins de deux unités astronomiques et ne diminue que très lentement, c'est pourquoi la comète présentera un faible objet d'observation.

En admettant que les changements de l'éclat suivent approximativement la loi $\frac{1}{r^4\Delta^2}$ et tenant compte de l'éclat observé pendant les apparitions anté-

rieures, on ne peut espérer que l'éclat de cette comète puisse dépasser celui d'une étoile de la 15-me grandeur.

Un second facteur peu favorable est la situation de la comète au ciel au point du jour dans les angles d'heures sensiblement orientaux. Pour les observatoires du nord cette circonstance est encore compliquée par la déclinaison méridionale de la comète.

Mais à l'aide de grands instruments installés à des latitudes pas trop septentrionales on pourrait quand même observer la comète, surtout parce que ses éphémérides sont assez précises.

De pareilles observations présenteraient un grand intérêt pour l'étude du mouvement de la comète parce qu'en faisant son tour prochain elle devra subir de considérables perturbations dues au Jupiter. Lorsque les éléments de son orbite seront corrigés à la base de nouvelles observations nous pourrons déterminer ces perturbations d'une manière plus précise.

Observatoire Astronomique Principal.
Département de Simeise.

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PHYSICS

ON THE PHOTOLUMINESCENCE OF THE SOLUTIONS OF RARE EARTHS SALTS

By J. LARIONOV and A. SEIDEL

(Communicated by A. D. Roždestvenskij, Member of the Academy, 19. VII. 1937)

We have shown already in our previous communications that strongly diluted aqueous solutions of terbium (1) and europium (2) salts exhibit bright photoluminescence with spectra consisting of a series of comparatively narrow bands. One of the authors of this paper has been able to show (3) that in the case of terbium these bands correspond to transitions from a single term of the configuration $4f^8$ on to all components of the multiplet ^7F, the ground term of this configuration. Somewhat later similar results were obtained by Gobrecht (4) who investigated the photoluminescence of solid solutions of rare earths in borax in visible and infra-red regions of the spectrum. Gobrecht arrived at similar conclusions also for Sm, Dy and Eu. Tomaschek and Deutschbein (5) in a recently published paper have confirmed these results for comparatively concentrated solutions of these rare earths in water and in organic solvents. The similarity of results obtained by us, on the one hand, and by Gobrecht, Tomaschek and Deutschbein, on the other, will seem to be still more remarkable if it is noted that our method of investigation differed essentially from that used by the German authors. While we used in our experiments diluted solutions (concentrations of the order of 0.001 per cent) exciting them in the region of continuous absorption in the far ultra-violet (6), Tomaschek with collaborators investigated concentrated solutions exciting them in narrow absorption bands of longer wave lengths. This difference of methods appears to display itself in some features of the phenomenon. So, we were able to show (7) that the structure of photoluminescence spectrum of solutions of terbium salts depends on the nature of the anion present in the solution. For the solutions of europium salts this dependence is still more evident: in our conditions the photoluminescence of europium could be observed only in the presence of traces of the SO_4(2).

Tomaschek and Deutschbein in their detailed paper do not mention these peculiarities [our recent communications (2, 3, 7,) seem to have remained unknown to them]. It may be supposed therefore that in the conditions of their experiment these peculiar features do not take place.

The difference in the methods of investigation explains also the divergence in the determination of the excitation region of the photoluminescence of terbium salt solutions (by us and by Tomaschek and Deutschbein). The cause of this divergence pointed to by Tomaschek and Deutschbein in a footnote seems to be quite clear and is to be explained by the difference in

the concentrations of the solutions investigated. The dependence of the region of excitation on the concentration was followed-up by us more closely for the solutions of europium sulphate. At small concentrations of $Eu_2(SO_4)_3$ ($\sim$0.01 per cent) its photoluminescence is excited by the wave lengths 2450—2750 Å, that coincide with the region of continuous absorption of europium. With the increase of concentration to 1—2 per cent these wave lengths cease to be effective; on the other hand, there appears a brighter photoluminescence excited in the narrow absorption bands in the near ultra-violet and visible regions of the spectrum. It is possible that this dependence of the region of excitation on the concentration of the solutions is caused by the change of the value of the coefficient of absorption of the light for different absorption bands. It is quite clear that in this case to every absorption band there will correspond a certain optimal concentration at which the photoluminescence excited in this band will reach its maximal brightness. However, this cause of the dependence of the region of excitation on the concentration is probably not the only one. It is very significant that the general aspect of the photoluminescence spectrum does not depend on the choice of the band in which the excitation takes place. This shows that the term from which the transitions accompanied by emission do occur remains always the same. It is noteworthy that the attempts to excite the photoluminescence of dilute solutions of Sm and Dy salts by the wave lengths coinciding with the region of their continuous absorption have failled. On the other hand, the concentrated aqueous solutions of the salts of these elements, in full agreement with Tomaschek and Deutschbein's data, are fairly well excited by the near ultra-violet. The cause of this peculiar behaviour of the solutions of the salts of these elements is not yet clear.

It was evidently very interesting to investigate besides the solutions of Tb, Eu, Sm and Dy also the solutions of the gadolinium salts. Gd^{+++} has seven *f*-electrons. The ground term of the configuration $4f^7$ ought to be a $^8S_{\frac{1}{2}}$ term (8), therefore, if the solutions of the salts of this element are exhibiting, indeed, a similar photoluminescence its spectrum ought to consist of single bands and not of multiplets observed in the spectra of Sm, Eu, Tb and Dy, the ground terms of which are ^7F, and ^6H terms. Since the bands of the photoluminescence of Gd^{+++} ought to coincide with its absorption bands, as it takes place for the short-wave component of the multiplets of the other rare earths mentioned above, the photoluminescence spectrum of gadolinium ought to be sought for in the ultra-violet where are lying all the absorption bands of Gd^{+++}. To make this point clear we have investigated aqueous 0.1—0.3 per cent solutions of gadolinium sulphate and chloride prepared of Prandtl's gadolinium oxide. We have made use of method and apparatus described in our previous communications. In both cases was observed the emission of an extraordinary bright narrow band lying at 311 mμ. This band coincides fairly well with one of the absorption bands of gadolinium solutions (6).

An investigation of the effeciency of different sparks and filters has shown that the excitation region of the gadolinium salt solutions lies between 2400 and 2700 Å. A spark between iron electrodes forms the most efficient source of excitation. These data agree well with the results of Tomaschek and Mehnert's (9) work on the fluorescence of solid salts and solutions of gadolinium, published after the completion of this part of our work.

It is to be mentioned that the band at 3108 Å detected by us in the europium salt solutions coincides exactly with this band of gadolinium, has the same aspect and is excited by the same wave lengths. It seems, therefore, that this band ought to be ascribed to gadolinium. The detection of gadolinium in a very pure sample of europium of Urbain by its photo-

luminescence spectrum points to a very high sensibility of the luminescence method and to the possibility of its use for analytical purposes, for the detection of gadolinium in other rare earths.

Already in our first paper ([1]) we referred to the possibility of analytical applications of the photoluminescence of the solutions of terbium salts. It is of interest to characterize the sensibility of this method. The sample of gadolinium used in our investigations exhibited in addition to the ultraviolet photoluminescence, as described above, also yellow-green luminescence belonging to terbium. According to Prandtl ([10]) the content of terbium in this sample did not exceed 0.01 per cent. The luminescence of terbium in this sample is yet fairly well visible at the concentration of 0.01 per cent gadolinium in the solution. Thus the detection of Tb by its luminescence is yet quite possible when its concentration in the solution is as low as 10^{-8} per cent. This limit lies much lower than that indicated by Tomaschek and Gobrecht ([11]) in their paper on the analytical applications of the fluorescence of the rare earths. The cause of higher sensibility in our case is quite obvious: the luminescence of terbium at low concentrations is excited much better by the nickel spark, than by the arc through a VUV-filter used by Tomaschek and Gobrecht.

A very high sensibility can be obtained also in the detection of Ce by the luminescence method. This problem will be dealt with in one of our next publications.

In conclusion we wish to express our appreciation to A. N. Filippov under whose guidance this work was carried out. We are also indebted to D. Rozdestvenskij and S. Wawilow, Members of the Academy, for the interest they have taken in this work and their many valuable suggestions.

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PHYSICAL CHEMISTRY

ON THE USE OF SOLID INDICATORS FOR DIRECT DETECTION OF PHOTODISSOCIATION PRODUCTS

By H. NEUJMIN

(Communicated by S. I. Wawilow, Member of the Academy, 21. VIII. 1937)

The use of solid indicators for the purpose of detection of free atoms, or radicals, presents several advantages in comparison with other methods.

Under this denomination usually are understood layers of some substances that disappear or change their properties in consequence of a reaction with certain atoms or radicals. Thus, for instance, films of metallic, Cd, Zn, etc. are used for the detection of the radicals CH_2 and CH_3. Under the action of these radicals volatile substances are formed and consequently the film disappears. For the capture of hydrogen atoms WO_3, MoO_3, $PbCl_2$ and other substances that change their colour when reduced by atomic hydrogen are generally used.

The method stated has the following advantages against ordinary chemical method for the study of decomposition products:

1) It allows to outgase thoroughly in vacuo the substances used as well as the reacting system, permitting thus to fulfill the experiment in very clean conditions.

2) By placing the indicators within the reaction zone itself the primary reaction products can be detected directly.

In comparison with the optical methods of the decomposition products the indicators present the following advantages:

1) They allow to detect the disintegration on unexcited products.

2) They allow to accumulate the action of unstable particles that have very low stationary concentration during large intervals of time.

Solid indicators have been used repeatedly for the study of thermal decomposition processes ([1]), for the investigation of decomposition in the electric discharge ([2]), and, generally, always when a considerable amount of decomposition products is being formed. In the case of photochemical processes, however, when the quantity of product formed is minute, it is to apprehend that the application of the method will be difficult owing to its small sensitivity.

Yet, in particular cases, solid indicators have been applied successfully to the study of decomposition under the action of light. Thus, for instance, Cario and Frank, and later Calvert ([3]) have detected the dissociation of molecules after collisions with mercury or xenon atoms excited by resonance; Pearson ([4]), as well as Prileżajeva and Terenin ([5]) have measured by this method the concentration of CH_3 and C_2H_5 resulted from photodissociation.

The present work deals with the tests of several indicators for captur of atomic hydrogen formed at the optical dissociation of various compounds.

A layer of molybdenum trioxide proved most sensitive and convenient. Among the other substances, successful results have been obtained with WO_3 and $PbCl_2$; other substances mentioned in the literature were either very unsensitive or inconvenient in use.

The hydrogen atoms produce an intensive blue colouring of molybdenum trioxide, caused by the formation of the so-called molybdenum indigo* on its reduction.

Molybdenum trioxide was obtained by heating a molybdenum wire with electrical current in air. MoO_3 is formed in these conditions as amorphous white «soot» readily settling on a cold surface.

The oxide was deposited in this way on a glass plate, forming a fairly dense layer (about 0.1—0.2 mm thick); the plate was then inserted through a ground connecting piece into the reaction vessel.

As a source of H-atoms the installation with powerful hydrogen tube was used that has been previously described ([6]) and employed for the investigations of optical dissociation of molecules in Schumann region. The plate covered with a layer of MoO_3 was placed out of the path of the exciting light beam, at the distance of about 1 cm, the surface of the plate being parallel to the beam.

When water vapour at about 0.5 mm pressure is irradiated by the non resolved light of the hydrogen tube (through a fluorite window), the blue colouring of the oxide layer appears after 10—15 minutes. In half an hour the layer has an intensely blue colour. On insertion of a quartz film, transmitting only wave lengths above 1500 Å, into the path of the exciting light beam, a considerably fainter colouring is obtained in the same interval of time.

Control experiments made with non resolved irradiation in vacuum and in water vapour non irradiated produced no noticeable change of colour of the layer. The region above 1850 Å had no effect either.

On irradiation of NH_3 vapours ($p \sim 0.5$ mm) a blue coloration of MoO_3 was observed, but considerably more feeble than for the H_2O vapour. The coloration is observed at the irradiation by wave lengths above 1850 Å as well.

Experiments with alcohol vapours gave a very feeble effect that can be attributed either to contamination by water vapour or else genuine formation of H-atoms (perhaps as result of some secondary processes).

The above data show that the method may be well applied not only for a qualitative but also quantitative (by means of colorimetric measurements) study of photodissociation processes leading to the formation of free hydrogen atoms.

For water vapour, the analysis of absorption spectra led to the hypothesis that light at about 1700 Å produces the dissociation into H+OH, while the light in the neighbourhood of 1400 Å gives H+OH*, OH* denoting the hydroxyl in the excited state $^2\Sigma$.

The latter hypothesis has been confirmed without any doubt by observation of an OH-fluorescence at 3062 Å on irradiation by the light of the above-mentioned region.

For the case of longer wave lengths the problem remained unsettled, because energetically such a dissociation should take place in the region of still more longer wave lengths. In fact, the process:

$$H_2O + h\nu \rightarrow H + OH, \qquad (1)$$

requires about 5 eV energy, while the long-wave limit of this absorption

* A product of inconstant composition, containing Mo_2O_5, MoO_3 and H_2O.

region is situated about 6.9 eV. From energetical considerations, the process requiring about 7 eV:

$$H_2O + h\nu \rightarrow H_2 + O^*, \qquad (2)$$

is more probable (O^* being an excited oxygen atom in the ^1D state).

The present experiments substantiate the first of the possibilities stated, for in irradiation of water vapour through a quartz film ($\lambda > 1500$ Å) a change of colour of MoO_3 is observed, i. e. H-atoms are formed, while at the dissociation according to the scheme (2) no hydrogen atoms should appear.

Evidently, the excess energy of the order of 1 eV is transformed into the kinetic or oscillation energy.

It is quite clear that under the action of the whole Schumann region (without the quartz film) a considerably stronger coloration is obtained, since in the short-wave region, also giving H-atoms, the absorption is much more intensive than in the long-wave region.

A very feeble blue coloration of the layer during the irradiation of ammonia vapour is in good agreement with experiments of Farkas and Harteck ([8]), who have established by other means that the concentration of atomic hydrogen at photo-chemical decomposition of NH_3 is very small.

The appearance of blue colouring proves that the decomposition process goes on according to the scheme:

$$NH_3 + h\nu \rightarrow NH_2 + H, \qquad (3)$$

instead of the other possible scheme:

$$NH_3 + h\nu \rightarrow NH + H_2. \qquad (4)$$

Thus, these experiments do substantiate the previously made hypothesis ([8,6]) on the dissociation of the ammonia molecule according to equation (3).

In experiments with water vapour the problem of the action of hydroxyl upon MoO_3 is not quite cleared up. Possibly the blue colouring is produced not only by H-atoms, but likewise by the OH-radical formed in the reaction. However, the reducing action of hydroxyl is not very probable, moreover this hypothesis perhaps should be rejected on the ground of very feeble effect in the case of alcohols where the splitting-off of hydroxyl might be expected.

It must be noted, lastly, that some tentatives were made for the detection of free H-atoms in the photo-chemical reaction H_2+O_2 excited by the Schumann region of the spectrum. The confirmation of presence of H-atoms would give an additional criterion for the verification of reaction kinetics, that has been proposed by the present writer in cooperation with B. Popov ([9]).

The experiments made appear to give a positive result (a feeble blue coloration of the MoO_3-layer), but the apparatus available did not permit to make the experiments in sufficiently clean conditions (owing to the presence of picein and glue). Therefore the experiments must be repeated in the same conditions as the study of the reaction (an all-sealed quartz vessel carefully outgased).

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CHEMIE

ÜBER EINEN NEUEN SUBSTANTIVEN FARBSTOFF

Von A. E. PORAI-KOSCHITZ, Mitglied der Akademie, und A. I. KULIKOV

Der Monoazofarbstoff aus dem Diazobenzol und der Naphthionsäure ist ein gewöhnlicher Säurefarbstoff, der keine «Affinität» zu Pflanzenfasern besitzt. Der symmetrische Disazofarbstoff aus bisdiazotiertem Benzidin mit 2 Mol. derselben Naphthionsäure ist dagegen das Kongorot, der bekannte Vertreter der substantiven Farbstoffe.

Eine solche Veränderung der Eigenschaften bei der streptostatischen «Verdoppelung» des Farbstoffmoleküls kann mit der bedeutenden Verlängerung der Kette von konjugierten Doppelbindungen in dem Molekül verbunden sein.

In der vorliegenden Arbeit, die im Jahre 1933/34 ausgeführt wurde, stellten wir uns die Aufgabe, eine analoge «Verdoppelung» des Moleküls an dem bekannten sauren Wollfarbstoff, Chinolingelb, vorzunehmen, um die dabei eintretende Veränderung der Farbe und der Färbeeigenschaften zu studieren.

Als Ausgangsstoff für diese Synthese diente uns das Bichinaldin (2:2′-Dimethyl-6:6′-Dichinolyn), das schon früher von Hinz [1] dargestellt wurde, jedoch mit sehr unbefriedigender Ausbeute. Deswegen haben wir eine veränderte Methode zu seiner Darstellung ausgearbeitet, die im wesentlichen auf der bekannten Döbner-Miller'schen Chinaldinsynthese beruht.

Benzidin wurde mit dem Paraldehyd beim Erhitzen in Gegenwart von konzentrierter Salzsäure und wasserfreiem Chlorzink kondensiert. Bei Verdünnen des Reaktionsgemisches mit etwas Wasser fiel ein gelber Niederschlag aus, der getrennt vom Filtrat, aber in derselben Weise bearbeitet wurde. Nach der gewöhnlichen Bearbeitung mit Nitrit in saurer Lösung—zur Befreiung vom Benzidin—und Kochen wurde die vom Harz abfiltrierte Lösung alkalisch gemacht, und die ausgefallene rohe Bichinaldinbase wurde schon nach Hinz durch das schwerlösliche Chromat gereinigt.

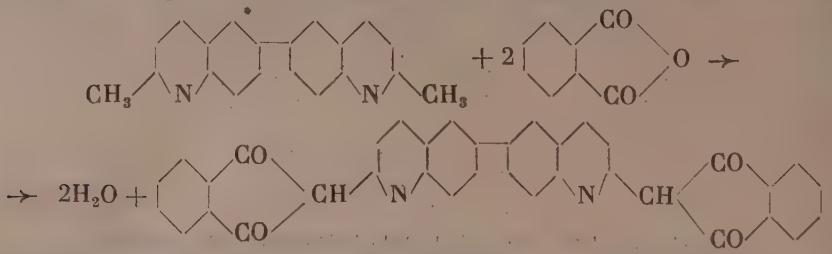
Aus dem obengenannten ersten gelben Niederschlag wurde dabei das Produkt mit dem Smp. 203—204° (statt 206—207° nach Hinz) unmittelbar erhalten, aus dem Filtrat dagegen etwas schmutziger, mit dem Smp. 171—180°. Für die weitere Verarbeitung jedoch waren beide Produkte genügend rein.

Die Gesamtausbeute wurde dennoch nur 8.8% der Theorie.

Da die Reaktion der primären Amine mit Paraldehyd eigentlich nur zu Dihydrochinolinderivaten führt, haben wir versucht die Reaktion in Gegenwart eines Oxydationsmittels zu führen, z. B. von Nitrobenzolsulfosäure, Zinkchlorid oder Arsensäure. Nur letztere gab dabei eine bedeutende Vergrösserung der Ausbeute (bis zu 17.6% der Theorie) mit der gleichzeitigen Erhöhung der Reinheit des Produkts.

Technisch ist auch diese Ausbeute unbefriedigend, aber für die Zwecke unserer Untersuchung war sie annehmbar.

Das so dargestellte Bichinaldin (1 Mol.) wurde mit Phtalsäureanhydrid (2 Mol.) durch Zusammenschmelzen zuerst bei 150—190° und dann bei 210—220° in Gegenwart von Zinkchlorid kondensiert:



Die feste Schmelze wurde mit kochendem Wasser, verdünnter Salzsäure und kochendem Alkohol gewaschen. Nach dieser Bearbeitung erwies sich das Produkt als ein genügend reines Bichinophtalon.

Analyse: 1) Einwage 0.2372; 11.6 ml N bei 18° und 758 mm. 2) Einwage 0.2294; 11.5 ml N bei 19° und 758 mm.

Gefunden: N 1) 5.79%, 2) 5.84%. Berechnet für $C_{36}H_{20}N_2O_4$: N=5.14%.

Die Substanz stellt ein dunkelgelbes Pulver dar, das bei 360° nicht schmilzt und in den meisten üblichen Lösungsmitteln unlöslich ist.

Dieses Produkt wurde mit 24%-igem Oleum zuerst bei 35—36°, dann bei 100° bis zur vollkommenen Löslichkeit in Wasser sulfuriert. Das Gemisch wurde auf Eis gegossen, mit Kochsalz ausgesalzt und getrocknet. Aus 2 Gewichtsteilen Bichinophtalon wurden 2.5 Gewichtsteile des in Wasser vollkommen löslichen gelbbraunen Natriumsalzes des Farbstoffs erhalten.

Beim Prüfen der Färbeeigenschaften erwies sich, dass es wirklich ein substantiver Farbstoff ist: er färbt Baumwolle in gewöhnlichen Bedingungen, in Gegenwart von Soda und Natriumsulfat, gold-eigelb an.

Die Verlängerung der Kette konjugierter Doppelbindungen, die durch die «Verdoppelung» des Chinolingelbmoleküls hervorgerufen wird, führt also auch hier für Baumwolle zur Substantivität des erhaltenen «Bichinolinrots».

Wolle wird mit diesem Farbstoff aus einem schwachsauren Bade bräunlich-gelb gefärbt, d. h. tiefer als mit Chinolingelb, das nur grünlich-gelb färbt.

Die Waschechtheit der Baumwollfärbungen ist 2—3, d. h. für einen substantiven Farbstoff ziemlich gut. Die Flotte wird gut ausgezogen.

Zum Unterschied gegen die einfacheren Benzidinazofarbstoffen, die bekanntlich fast alle Indikatoren sind, ist das «Bichinolingelb» vollkommen säure- und alkaliecht. Das ist auch verständlich, da in seinem Molekül keine Tautomerisation in eine Hydrazonform wie in den Azofarbstoffen möglich ist.

Das Bichinolingelb könnte auch selbst eine gewisse technische Bedeutung erlangen und als Vertreter einer neuen Klasse substantiver Farbstoffe erscheinen, die aus anderen Diamino-diarylbasen dargestellt werden könnten, wenn es gelingen würde, ein billigeres und einfacheres Verfahren mit besseren Ausbeuten zur Darstellung der Bichinaldinderivate aus diesen Basen zu finden. Unsere Versuche in dieser Richtung werden fortgesetzt.

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ZITIERTE LITERATUR

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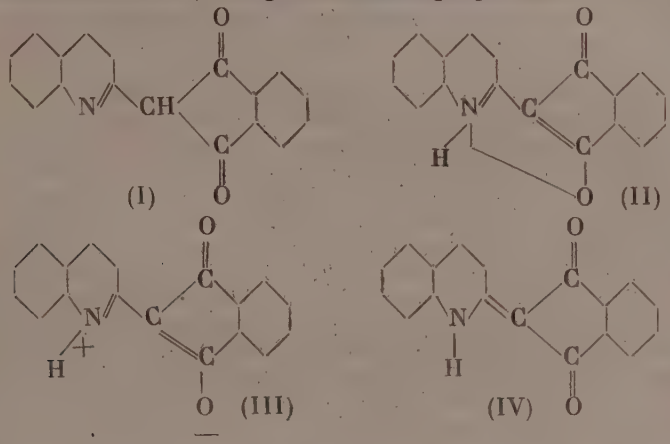
CHEMIE

ZUR KONSTITUTION DES CHINOPHTALONS

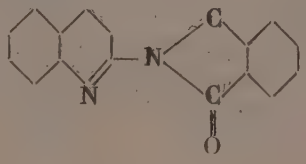
Von A. E. PORAI-KOSCHITZ, Mitglied der Akademie, B. A. PORAI-KOSCHITZ und S. A. LUICK

Die gelbe Farbe des Chinophtalons kann nicht durch die auf Grund der Darstellungsmethode früher angenommene (1) Konstitutionsformel desselben (I) erklärt werden. Besser ist in dieser Beziehung die von Kuhn (2) vorgeschlagene Betain- (II) oder Dipolformel (III). Ausserdem ist noch eine dritte tautomere Formel (IV) denkbar die in der sehr verbreiteten Tautomerie der Chinolinderivate (3) eine gewisse Bestätigung findet:



Auf Grund dieser Vorstellungen spielt in der Fabre des Chinophtalons eine grosse Rolle das Wasserstoffatom, das in der Formel (I) bei dem mittleren C-atom sich befindet und bei der Tautomerisation zum N-atom übergeht. Durch diesen Übergang wird in dem Chinolinmolekül eine Kette der konjugierten Doppelbindungen geschaffen, die für das Erscheinen der gelben Farbe genügend lang ist. Wenn dies der Fall ist, so muss eine Verbindung, die eine der Formel (I) analoge Konstitution hat, die aber kein Wasserstoffatom bei dem zentralen Atom enthält, farblos sein.

Zur Bestätigung dieser Annahme und damit auch der Existenz der tautomeren Formen (II), (III) und (IV) des Chinophtalons wurde von uns das α-Chinolylphtalimid synthesiert:



Infolge der Abwesenheit des Wasserstoffs bei dem zentralen N-atom sind für diese Verbindung die den Formen (II) und (III) des Chinophtalons analoge Formen unmöglich.

Diese Verbindung erwies sich wirklich als farblos und diese Tatsache bestätigt die Tautomerie des Chinophtalons und die Existenz der Konstitutionsformen (II), (III), oder (IV), oder vielleicht aller diesen Formen.

Experimenteller Teil

Das Ausgangsmaterial, α-Aminochinolin, wurde nach [4] durch Einwirkung von frischem Natriumamid auf das trockene Chinolin in trockenem Toluol dargestellt. In die Bearbeitung des Gemisches wurde eine Veränderung eingeführt: nach der Beendigung der Reaktion wurde aus dem Gemisch das Toluol und das unveränderte Chinolin mit Wasserdampf abdestilliert, dann wurde die heisse wässerige Lösung des α-Aminochinolins von der zähen Masse des Dichinolins abgetrennt, heiss filtriert, bis zur Hälfte verdampft und erkalten lassen. Beim Erkalten kristallisierte aus der Lösung das α-Aminochinolin in Form weisser Blättchen mit Smp. 120—124° (das Smp. des reinen Produkts ist 129°). Die Ausbeute beträgt 5—8% der Theorie.

Durch Umsetzen des α-Aminochinolins mit Phtalsäureanhydrid in Chlorbenzol bei 60—80° wurde dasselbe in die α-Chinolylphtalaminsäure übergeführt (weisse Nädelchen Smp. 187—188°; löslich in Alkalien, heissem Wasser, heissem Alkohol), die beim Verbrennen 69.42% C und 4.17% H ergab (berechnet 69.86 und 4.11%).

Die α-Chinolylphtalaminsäure verliert beim Erhitzen über den Schmelzpunkt in trockenem Zustande, oder in einem hochsiedenden Lösungsmittel (z. B. Dimethylanilin) das Wasser unter Bildung von α-Chinolylphtalimid (weisse Nädelchen, Smp. 238—239°, aus Benzol; unlöslich in Wasser, leicht löslich in Benzol, etwas weniger in Alkohol). Die Analyse ergab 74.32% C, 3.92% H und 10.59% N (berechnet 74.45, 3.65 und 10.22%).

Diselbe Substanz wurde auch unmittelbar aus α-Aminochinolin und Phtalsäureanhydrid beim Erhitzen auf 205—210° in Dimethylanilin erhalten.

Das α-Chinolylphtalimid kristallisiert aus Alkohol teilweise frei, teilweise aber mit 1 Mol. Kristallalkohol in grossen weissen Kristallen mit Smp. 138—139°, die beim Trocknen bei 120—130° 14.51% ihres Gewichts verlieren (berechnet 14.37%) und in ein Pulver mit dem Smp. 237° zerfallen.

Analog α-Chinolylphtalimid wurde auch α-Pyridylphtalimid (farblose Nadeln, Smp. 228°) aus α-Aminopyridin und Phtalsäureanhydrid erhalten.

Schlussfolgerung

Die Farblosigkeit von α-Chinolyl- und α-Pyridylphtalimid ist ein Argument für die Existenz der tautomeren Formen (II) und (III) des Chinophtalons, die die Anwesenheit eines zum Stickstoffatom übergehenden Wasserstoffatoms bei dem zentralen Kohlenstoffatom verlangen.

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GEOCHEMISTRY

ON THE COMPOSITION OF THE MUD OF THE BRINE OF THE KARABUGAZ GULF

By L. S. SELIVANOV

(Communicated by V. I. Vernadsky, Member of the Academy, 31. VII. 1937)

While working at Karabugaz in 1931—1932 I collected a small amount of thin mud suspended in the brine of the gulf. The mud, which communicates a peculiar dull-gray hue to the brine of the gulf, was obtained from 40 litres of the brine after its having stood for two months. The brine was taken near the landing of the Sartas salt works at the end of October 1932. The mud was a thin, very slowly filtrating, almost white sediment which having been kept during four years under the layer of the brine, from which it had been obtained, was covered with pinkish and green spots. In order to analyse the sediment the brine above it was decanted, the residue was as completely as possible separated by straining, the substance remaining in the filter was brought to a constant weight at 103—105° and subjected to an analysis. As straining failed to entirely remove the brine (washing was not applied in view of the expected presence of gypsum), the dry residue of which represented, as it was eventually found, almost 40% of the substance obtained,— an estimation of the quantity of salts belonging to the brine had to be resorted to. The estimation was performed in the following way. From a weighed quantity of the substance dissolved in nitric acid (without Cl) was determined chlorine, and from its quantity an estimation of the other elements was made, viz.: Ca, Mg, SO_4, etc., introduced into the substance by the brine which also was analysed.

The results of the analysis of the brine, of the substance obtained as above described (mud together with the residue of the brine) and the estimated composition of the mud are given in the following table:

1		2		3	
CO_3''	0.002%	$Ca^{\cdot\cdot}$	6.18%	$MgCO_3$	53.12%
HCO_3'	0.091	Mg	12.46	$CaCO_3$	18·68
Ca''	0.044	Fe_2O_3	3.71	$CaSO_4$	7·52
$Mg^{\cdot\cdot}$	1.493	SO''_4	9.23	Fe_2O_3	5.82
SO_4''	3.206	Cl'	19.29	Undissolved sediment	14.86
$Cl'+Br'$	10.74	CO_3**	31.27	Total	100·00%
$Na^{\cdot}$*	5.66	Undissolved sediment	9.47		
Total salts	21.23	Residue of the brine***	10.59		
Dry residue	21.38	Total	102.20%		
d	1.172				

The above figures primarily show an overwhelming predominance of $MgCO_3$ over $CaCO_3$. This fact is corroborated by the old (unpublished) analysis of that part of the mud which is indissoluble in water. This analysis

* Sodium was estimated according to the excess of anions

** No determination was made because of the scarcity of the substance. It was computed from the balance of $Ca^{\cdot\cdot}$ (remained from SO''_4) and from $Mg^{\cdot\cdot}$, which were taken as $CaCO_3$ and $MgCO_3$

*** The residue of the brine was estimated from analysis 1 and the quantity which had been found from analysis 2.

was made by P. A. Kolodub who was so kind as to allow the author to avail shmself of the data obtained in his investigations. He found the correlation $MgCO_3/CaCO_3$ in the mud taken from the same region to be equal to 4.95, i. e. exceeding that found by the author (2.85). Of great importance is, furthermore, the presence in the brine of a very thin suspension of substances (probably argillaceous) which are capable of inducing under certain conditions some absorption phenomena.

By means of the above analysis it seems to be possible to elucidate certain details of the hydro-chemistry of the Karabugaz gulf. Having been undertaken with a view to verifying the assumption that Heidinger's reaction $2CaCO_3 + MgSO_4 \rightleftarrows MgCO_3 . CaCO_3 + CaSO_4$ may take place in the conditions of the gulf (it was assumed that the mud is a metamorphized $CaCO_3$ dropped from the condensating sea water), the analysis unexpectedly yielded very high numbers for $MgCO_3$ from which we may surmise that either Heidinger's reaction proceeds considerably beyond the formation of dolomite, or that an independent source of $MgCO_3$ is present in the gulf, e. g. that this salt is dropped along with $CaCO_3$ from the condensating sea water. The experiments performed by N. S. Kurnakov and S. F. Žemčužnij[1], as well as the data formerly obtained by A. A. Verigo show, however, that the precipitates resulting from the action of magnesium salts on calcium bicarbonate contain a relatively small amount of $MgCO_3$. When $CaCO_3$ is treated with the Karabugaz salt water in solid state no further substitution of Mg for Ca is recorded and Heidinger's reaction written in the above stated form does not take place in the conditions of Karabugaz. This conclusion is corroborated by the experiment performed by the author at the end of 1932 which was completed in 1936. Pure $CaCO_3$ in the form of powder was put into a hermetically closed flask which was kept (being shaken off from time to time) under the usual laboratory temperature and pressure. After termination of the above period (i. e. almost 4 years later) the residue under the brine, the brine itself as well as the control sample of the brine, which was kept under the same conditions, were subjected to an analysis. In determination of the composition of the residue (which was carried on in the same way as for the mud) it was found that with the elimination of the salts of the brine it is composed of $CaCO_3$ without admixture of $MgCO_3$ and gypsum.

A comparison of the composition of the control sample of the brine (see analysis) with that of the brine poured off from the precipitate $CaCO_3$ and strained in the same way as the control sample shows that the percentages of all ions with the exception of $Ca^{\cdot\cdot}$, $CO_3^{\prime\prime}$ and $HCO_3^{\prime}$ converge within the limits of accuracy of determination of the composition of both samples. As to the latter ions, they all show an obvious decrease of concentration in the second sample of the brine (see data in the table). It is seen from the table that the difference in concentration of calcium, expressed in mg-equivalents in a litre of the brine, is equal to the change in the alkali reserve (i. e. $[CO_3^{\prime\prime}] + [HCO_3^{\prime}]$), expressed in the same units.

Composition of the control sample of the brine		Composition of the control sample of the brine (1) as compared with that poured off from $CaCO_3$ (2)				
			$CO_3^{\prime\prime}$	$HCO_3^{\prime}$	$Ca^{\cdot\cdot}$ b%	$Ca^{\cdot\cdot}$ mg-eqv./l	Alkali reserve mg-eqv./l
$CO_3^{\prime\prime}$	0.008%						
$HCO_3^{\prime}$	0.069						
$SO_4^{\prime\prime}$	2.905	1.	0.008%	0.069%	0.0459	26.64	12.79
$Cl^{\prime} + Br$	10.42	2.	0.002	0.057	0.0404	23.41	9.89
$Ca^{\cdot\cdot}$	0.0459						
$Mg^{\cdot\cdot}$	1.427				Difference	3.23 mg-eqv./l	2.90 mg-eqv./l
$Na^{\cdot}$	5.43						
Total salts	20.31						
Dry residue	20.41						
d	1.163						

The above values do not raise any doubt, so far as the method is concerned, as calcium was determined by means of Gubareva's method (2), which is an excellent one in respect of the convergence and accuracy of the results (in both cases a mean of two determinations is given, the divergence being not more than 0.0003%), and the quantities of concentrations of CO_3''- and HCO_3'-ions, which to a considerable extent are conditional values, were checked up with the determinations of the alkali reserve made after P. Danilchenko and M. Ravich(3).

Calcium in the form of $CaCO_3$ thus dropped out of the brine which had been supersaturated with this ion. Calcium carbonate proved to be a factor which disturbed the supersaturation as is usually the case with fresh water (4). Supersaturation with Ca-ion, which is usual in fresh waters (5) and is probable in respect of sea water (6) *, appears to be also a characteristic of the saline reservoir of Karabugaz reaching in the case under consideration 115% of the normal content. It may be assumed, on the other hand, that the brine of Karabugaz is not always saturated with calcium as its concentration as well as that of ions CO_3'' and HCO_3' are subject to considerable fluctuations, declining sometimes up to and even below the undermentioned concentration which corresponds to the equilibrium of the $CaO—H_2O—CO_2$ system. Numerous examples can be found in the publication by V. Ilinsky a. oth. (7). Below are given only the data obtained by the author from analyses of samples taken at great depths at the station with coordinates about 42°00′N and 3h30′E made on June 14th 1932, (depth of the station—8.0 m).

Depth of the samples taken	Surf.	1.0 m	2.0 m	3.0 m	4.0 m	5.0 m	6.0 m	7.0 m	8.0 m
$Ca^{\cdot\cdot}$	0.044%	0.103%	0.049%	0.055%	0.053%	0.044%	0.044%	0.074%	0.020%
CO_3''	0.010	0.011	0.014	0.014	0.013	0.013	0.008	0.013	0.010
HCO_3'	0.072	0.057	0.045	0.043	0.047	0.047	0.050	0.047	0.056
Dry residue	21.30	21.42	21.39	21.34	21.36	21.38	21.33	21.99	22.77

In spite of the fact that the dry residue is practically constant for the first seven samples (as well as the concentrations of the other ions not mentioned in this paper), the content of $Ca^{\cdot\cdot}$-ion fluctuates within a very wide range. Unfortunately, it is hardly possible to utilize here the computations by means of which is determined the state of the system $CaO—H_2O—CO_2$ in sea and fresh water conditions as, besides very high salinity, of great importance here is, according to data of V. Ilinsky, (8) and P. Danilchenko and M. Ravich (3), the system $MgO—H_2O—CO_2$ which introduces entirely new correlations.

It is of interest to compare the above described sediment from the brine with the thin white silt found at a number of points in the gulf, which covers the deposits of mirabilite with a layer sometimes several centimetres thick. The white silt, which is in appearance analogous to the sediment of the brine, was collected by the author at the station mentioned above. Its presence at a number of points in the gulf has been pointed out by A. Mikhalevsky (9) and V. Ilinsky and others (7) in a recently published work. The sample collected by the author, being analysed by him and P. A. Kolodub showed a predominance of $MgCO_3$ over $CaCO_3$. Ilinsky gives in his abovementioned work a number of analyses of the white silt unseparated, unfortunately, from the brine by which it is moistened. The relation $MgCO_3/CaCO_3$

* H. Wattenberg as well as a number of other authors consider the supersaturation with calcium as common in some of the regions of the Atlantic ocean. His conclusions, however, require verification as they are all based on the values computed for $Ca^{\cdot\cdot}$-ion.

greatly fluctuates in some of the samples—from 7.99 to 0.25—those sample where the relation $MgCO_3/CaCO_3$ is small (with the only exception of ana lysis 22) showing a tendency towards special enrichment with gypsum. In individual cases the composition of the white silt closely approaches that of the above determined mud, and there appear to be sufficient grounds to associate genetically two formations in spite of the process of metamorphism which is very pronounced in some cases, as it appears from the relation $MgCO_3/CaCO_3/CaSO_4$. It is, furthermore, not improbable that a certain part in the formation of the white silt was played by particles of dust brought from the shore by winds ([9]), as well as by particles of silty matter transported by streams of rain water,—a phenomenon which was observed by the author on a large scale near Kulan-Gurlan cape.

In conclusion, certain features of the change in the alkali reserve with the depth of the gulf must be mentioned. M. Belenkij and V. Žuzet ([10]) found the characteristic course of this magnitude: the nearer it is to the bottom, the smaller it is, sometimes undergoing a sudden and abrupt fall at the depth of 7—8 m. A. D. Pelsh ([11],[12]) associate this phenomenon with a peculiar distribution of the mud at different depths of the gulf: he holds that the excess of the alkali reserve in the layers of water close to the surface is connected with the large quantity of mud contained therein, which is retained there by agitation of the water. The layers close to the bottom, on the contrary, being less intermixed, contain less mud in suspension which rather quickly settles here to the bottom. The author does not share the view held by A. Pelsh as a direct determination shows that from a litre of the brine taken from the surface of the gulf not more than 0.02—0.03 g of the suspended mud settles within two months. All this quantity may increase the alkali reserve of the brine only by 0.3—0.5 mg-equivalents, i. e. by a value at least seven times as low as the difference which was found in some of the observations made by M. Belenkij and V. Žuzet. From the data obtained by these investigators it also appears that a considerable gradient of the alkali reserve was also taking place at small depths at which the water is undoubtedly thoroughly mixed up. The observed effect can hardly be explained by means of the suspended mud, in any case this would require an investigation of the water on the spot, or at least the possibility of separation of a part or the entire mud from the brine during keeping of the latter should be taken account of.

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GENETICS

ON THE HETEROZYGOSITY OF THE MALE SEX IN *FRAGARIA ORIENTALIS* LOS.

By D. F. PETROV and D. A. TUKAN

(Communicated by N. I. Vavilov, Member of the Academy, 4. VIII. 1937)

The problem of sex seems to be one of the most interesting but still yet a rather vague domain of genetics.

The genus *Fragaria* with its either purely hermaphroditic or, as a rule, purely diclinous species, appears to be the most convenient object for the experimental study of the sex evolution problem.

The works of Valleau (6), Correns (1), Schieman (5) and Lilienfeld (2) showed that the female sex is heterozygous in *F. elatior* Ehrh. ($2n=42$), *F. chiloensis* Ehrh. ($2n=56$), *F. virginiana* Duch. ($2n=56$) and *F. grandiflora* ($2n=56$).

In the investigation of megasporogenesis in the female plant of *F. elatior*, Kihara (3) even succeeded in finding heterochromosomes. *F. vesca* L., *F. collina* and other seven-chromosome species, as it is well known, always have only hermaphroditic flowers.

According to the data of one of the authors of this article [Petrov and Shashkin (4)], *F. orientalis* Los., having the diploid chromosome number 28, as a rule, possesses either purely male or purely female flowers. The question as to what sex in this species appears to be heterozygous still remains open. We communicate below some data concerning this question.

In 1935 twenty eight flowers *F. vesca* were emasculated and pollinated with pollen of *F. orientalis* Los. ($2n=28$).

From this crossing 890 seeds were obtained, which germinated in the spring of 1936. In this family 16 plants bloomed in 1937, nine of them having purely female and seven purely male flowers.

According to the nature of flowers, leaves and scapes of these plants they somewhat resembled *F. orientalis* but their appearance in general was intermediate between *F. vesca* and *F. orientalis*.

The pollen in male F_1 plants was nearly 100% abortive, the female plants also being sterile.

Since, in respect of factors determining the development of hermaphroditic flowers *F. vesca* is homozygous, then from the fact of occurrence from the crossing between *F. vesca* and F. *orientails* of F_1 plants of purely female or purely male flowers, one is led to the conclusion that the male sex in *F. orientalis* is heterozygous.

Let us now analyse the question concerning the importance of this fact in regard to the evolution of mechanism determining the inheritance of sex.

As we know, the mechanism of inheritance becomes disturbed in the inception of polyploids, from which it follows that with newly arisen polyploid forms the mechanism of the sex inheritance is produced anew (which incidentally appears to be one of the greatest obstacles to the occurrence of polyploid forms in animals).

All the initial diploid species in *F. orientalis* are purely hermaphroditic.

In the processes of differentiation of sexual groups in the tetraploid *F. vesca orientalis* Los. it was the male sex which appeared as heterozygous. On the contrary, in the hexaploid *F. elatior* Ehrh. and in octoploid species of *Fragaria*, the female sex appeared as heterozygous indicating that the question which of the sexes will appear as heterozygous cannot be anticipated by structural peculiarities of initial species, but, on the contrary, finds solution in the actual evolutionary process itself of sex differentiation.

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PLANT PHYSIOLOGY

THE PRODUCTION OF THIOUREA BY FUNGI

By K. E. OVČAROV

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The power of the lower plants to build up and decompose urea during their nitrogen exchange has been proved by Miguel's investigations (5). The subsequent work of Fosse (10), Ivanov (7), Klein and Taubröck (4), Imai (6), Chrzaszcz and Zakomorny (11), etc., indicate the wide distribution of urea in plant organisms.

More recently N. N. Ivanov has traced the dynamics of the content of urea in fungi during their development and has established its role in the nitrogen exchange of fungi. Ivanov considers that urea fulfils in the nitrogen metabolism of fungi the same role as do aspargin and glutamin in the higher plants.

Klein and Farkass (3) have found during their analyses of urea in the higher plants that in addition to urea two-week old seedlings of *Laburnum Anaagyroides* also contain thiourea, its analogue. Not a single paper has appeared on this extremely interesting compound since the investigations by Klein and Farkass. The conditions of production and distribution of thiourea and the part it plays in the metabolism of the higher plants remained quite obscure.

Method of Determining Thiourea

The determination of thiourea in vegetable matter is rendered difficult by the absence of precise quantitative methods of its determination. The only method of estimating thiourea proposed by Klein (coloured reaction with red blood salt) is suitable for qualitative estimations only.

For the purpose of comparing the results obtained by Klein's method we made use of spectroscopical analysis. The possibility of applying the spectroscopic method to determinations of thiourea is due to its physical properties, namely, to its power of intense absorption of ultra-violet rays. It is likewise possible to judge, by the intensity of absorption of ultra-violet rays, of the greater or lesser content of thiourea in the solution.

Determinations of thiourea after Klein and by the spectroscope* gave identical results in our investigations.

Thiourea was determined as follows: the medium of a fungal culture was discoloured by animal charcoal. Half of the discoloured extract was taken

* The spectral analyses were made by M. Zelenin, of the Laboratory of Radiant Energy of the Biological Association of the Academy of Sciences of the USSR.

for spectral analysis and half for estimation after Klein's method (2). Klein's method consists in the following: potassium ferricyanide (0.5 cm^3 of an 0.5% solution) and chemically pure acetic acid (5 cm^3) are added to the extract examined. The appearance of a blue tint on warming indicates the presence of thiourea in the solution. For determinations of thiourea in normal plants and in those infected with fungi the thiourea was extracted as follows: the dry material was immersed in alcohol and extracted by heating for 5 hours; then filtered. The alcohol was then distilled off and the residue dissolved in water. The aqueous extract obtained was then discoloured by charcoal. The discoloured extracts were analysed.

The Effect of the Composition of the Medium on the Formation of Thiourea in Fungi

For the purpose of elucidating the dependence of the production of thiourea on the nature of the nitrogen source in medium, we took a 15-day-old culture of *Botrytis cinerea*, cultivated on Richard's medium with the addition of various nitrogenous substances.

The results of this experiment were as follows *:

$NaNO_3$	0
Gelatin	+
Casein	+
Aspargin	++
$(NH_4)_2SO_4$	++

Analogous results were obtained with *Verticillium albo-atrum*:

Casein	+
Peptone	++
NH_4NO_3	++++

The above data show that the maximum quantity of thiourea accumulates when fungi are cultivated on aspargin and ammonium salts. No thiourea were found in cultures containing nitrates.

Different fungi grown under identical conditions accumulate thiourea differently. Thus *Fusarium* sp., *Vert. albo-atrum* and *Botr. cinerea*, cultivated on a sugar-ammonium medium accumulated thiourea in the following amounts:

Fusarium sp. (from the section *Gibbosum*)	0
Verticillium albo-atrum	++++
Botrytis cinerea	++

Thiourea in Plants Infected with Rust

A. A. Richter and A. I. Grečušnikov (8) were first to isolate the toxins of rust and to study their effect on the tissues of a higher plant. In subsequent papers Grečušnikov (1) studied in detail the chemical nature of toxin preparations. In addition to ammonia Grečušnikov discovered in plants infected with rust the presence of urea and studied its effect on the photosynthesis, respiration, transpiration and permeability of plants.

In a more detailed examination of the products of the activity of rust, we have determined in addition to ammonia and urea, likewise the presence of thiourea in the following amounts:

Rubus saxatilis L, uninfected	+
» » » , infected with rust	+++
Alchemilla vulgaris L., uninfected	+
» » » , infected with rust	+++
Rhamnus cathartica, uninfected	+
» » , infected with rust	+++

* Symbols: 0, no thiourea; +, traces; ++, present; ++++, much.

The above results show that thiourea can be produced not only by semi-parasitic fungi but also by true parasites.

Modifications of Physiological Processes under the Effect of Thiourea

It was interesting to trace the modification in physiological processes under the effect of thiourea artificially introduced into the cell. The specificity of ureasis precludes the fermentative splitting-up of thiourea. Thiourea must, consequently, remain for a long time in the cell and produce modifications in the state and processes of the upper plants. The introduction of thiourea into the tissue and the measurement of the subsequent processes of photosynthesis allow of a fuller development of the notions expressed by Grečušnikov on the action of the toxins of rust, and enlarge our knowledge of the factors producing internal changes in the organism of plants infected with fungi.

In our experiments plants intoxicated with thiourea lost their turgor (though to a lesser degree than under the action of urea), increased considerably the discharge of water by transpiration, changed their colour (table 2), modified the energy of photosynthesis.

The change in intensity of photosynthesis depended both on the duration of the injection of thiourea and on the properties of the plant. Plants, suffering from rust respond less readily to injected thiourea than uninfected plants. The results of determinations of photosynthesis are represented by Table 1.

Table 1

Quantity of CO_2 in milligrams assimilated by 1 m² of leaf surface per hour. Determined in a current of air by means of A. A. Richter's apparatus (°)

	Water	Thiourea	Susceptibility to rust disease
Tomato (*Sol lycopersicum*)	61.5	1.45	Not susceptible
Tussilago Farfara	166.4	28.1	Susceptible (*Pucc. Poarum* Niels.)
Ranunculus acer L.	29.1	34.95	Susceptible (Rust species not identified by us)

We are inclined to see the lowering in the energy of photosynthesis under the effect of thiourea not only in the water deficit of the assimilating organs of the plants (see below). In addition to the water deficit, an important role, may be even the main role, is played by the direct action of the thiourea on the assimilating organs. We have observed that on the introduction of a weak solution of thiourea (0.1 m) into cut plants there occurs a discolouring of the chlorophyll in the leaves. These observations are summarized in Table 3.

Sunlight accelerates considerably the destruction of chlorophyll on the introduction of thiourea into the living plant.

It had seemed at first sight that this destruction was caused by the direct action of the thiourea on the chlorophyll. A more detailed study showed, however, that the addition of an 0.7% alcohol solution of thiourea to an alcohol extract of chlorophyll instead of accelerating the destruction of the chlorophyll had, on the contrary, considerably increased its stability.

Table 2

Plants kept for 48 hours in solutions of urea (0.6%) and thiourea (0.7%)

	Water	Urea	Thiourea
Wheat (*Lutescens* 062)	Full turgor of the leaves. No signs of yellowing	Leaves wilted. Very faint signs of yellowing	Wilting slight. Leaves strongly yellowed (colour yellowish-brown*)
Tomato (*Sol. lycopersicum*)	Turgor. No yellowing noticeable	Leaves strongly wilted. Yellowing very slight. 70% of the leaves quite green	Wilting slight. All the leaves yellowish-brown*
Alchemilla vulgaris L.	Turgor. No yellowing	Leaves wilted. Yellowing partial. Majority of the leaves lack even such yellowing	Wilting very slight. Majority of the leaves yellowish brown*
Ranunculus acer L.	Turgor. No yellowing	Leaves slightly wilted.* Yellowing partial	Wilting slight. Majority of the leaves yellowish-brown *

Table 3

	After one hour past	After three hours	After ten hours
Alcohol	Green colour	Noticeable brown colour	Yellow colour
Urea	» »	Yellow colour	» »
Thiourea	» »	Green »	Light green colour

It, therefore, seems to us that thiourea does not affect the chlorophyll directly, but through the cell plasm or through the stroma of the plastids.

We draw the conclusion that thiourea is, similarly to urea, a widely distributed amide, especially in fungous growths.

In cases of symbiosis of a parasitic fungus or saprophite with a higher plant, the thiourea excreted into the tissue of the plant produces in the latter a modification in the photosynthesis energy and in the colour of the green leaf (yellowing and necrosis).

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* The discoloration of the chlorophyll from thiourea is strongly reminiscent of destruction of chlorophyll in verticillous and rust diseases.

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PLANT PHYSIOLOGY

SPECIFIC ACTION OF DROUGHT ON WHEAT CROPS AT VARIOUS STAGES OF DEVELOPMENT

By I. A. STEFANOVSKIJ and I. V. GUŠČIN

(Communicated by A. A. Richter, Member of the Academy, 17. VII. 1937)

The object of this work is to ascertain the causes responsible for the decrease of yield under the action of drought. Experiments were made on varieties of the greatest practical value to Transvolga districts, the selections having been made by the Saratov and the Krasnokut stations.

Amongst the common varieties were represented: 1) lutescens 062; 2) erithrospermum 0841, 3) melanopus 069; and amongst the prospective ones, hard beardless wheat, 4) candicans 02116; also 5) melanopus 01932 and 6) alborubrum 02225. The work was done at the Krasnokut Plant Breeding Station in 1936 and partly in 1935, the experiments being made in a greenhouse by the Tumanov wilting method (1). The wheats were sown in flower pots holding 4—5 kg earth each, the sowing being repeated four times. Six series of experiments were made. In the first series, the plants were grown with optimal humidity, and were used as control. In the remaining series, drought was brought about by an absence of watering during the periods of tillering, stalk-shooting earing, beginning of seed formation and ripening.

As regards meteorological conditions, the year 1935 and more especially 1936, were very droughty, when not only soil drought, but also atmospheric drought prevailed, and this was one of the causes of a poor yield in the vessels even with optimal humidity.

Drought and the Vegetative Period

As regards the vegetative period the varieties under investigation showed a great similarity, the extreme earing dates varying only within two days.

As shown by the experiments, drougths occurring at different stages of development affect differently the rate of development of the plant.

If wilting occurs at the tillering or stalk-shooting stage, earing is retarded by the arrested growth of the plant. Thus, in the case of some varieties of erythrospermum, earing began on June 19 in control plants, and on June 22 in the case of wilting at the tillering or stalk-shooting stage, the difference being 3 days. The other varieties were similarly affected, their ripening being also retarded by 2—6 days as compared with control plants. Those plants, however, that had been exposed to drought at the earing—flowering and seed ripening stages ripen-

ed much more rapidly. For such varieties as 0841 and 069, the acceleration of ripening ran into 5—6 days.

The Influence of Soil Drought on the Yield

The yield is a result of the development of the plants under definite external conditions. It may be divided into the following elements: 1) number of ear-bearing stalks, 2) number of grains in the ear and 3) absolute weight of the grain. If the plant is exposed to drought at different stages of its development, the correlation of these elements undergoes considerable changes.

Thus, the length of the ear which is an indirect index of the yield, changes as follows under the action of drought.

Table 1

Influence of Drought on the Lenght of Ear

Varieties of soft and hard wheat		Lenght of ear in cm		
		Drougth during		Control
		tillering	stalk-shooting	
Soft	Erythrospermum 0841	4.6	3.3	5.0
	Lutescens 062	4.2	3.1	5.7
	Alborubrum 02225	4.4	3.8	4.8
Hard	Melanopus 069	3.1	3.1	4.1
	Melanopus 01932	3.5	3.2	4.2
	Candicans 02116	3.9	3.1	3.6

It may be seen from the above table that plants exposed to drought before the ear has been fully formed show a decreased ear length, this effect being most pronounced if wilting occurs at the stalk-shooting stage, when the ear also often becomes distorted.

Thus, in erythrospermum 0841 the length of the ear is reduced from 5 cm to about 3.3 cm, in lutescens 062, from 5.7 to 3.1 cm. The same is observed with regard to hard wheats. After the ear has been formed its length is no longer affected by drought. The number of grains in the ear is somewhat differently affected by drought.

Table 2

Variations in the Number of Grains in the Ear with Droughts Occurring at Different Stages of Development

Varieties of soft and hard wheat		Number of grains in the ear if drought occurs during				Control
		tillering	stalk-shooting	earing	ripening	
Soft	Erythrospermum 0841	12.0	4.2	8.4	15.5	16.7
	Lutescens 062	10.4	3.8	2.6	16.0	17.0
	Alborubrum 02225	8.0	7.8	4.5	15.0	15.0
Hard	Melanopus 069	11.3	1.2	2.0	13.0	14.5
	Melanopus 01932	9.0	1.0	1.8	10.6	11.9
	Candicans 02116	13.8	0.6	6.0	10.7	13.8

Similarly to ear length, the number of grains shows a catastrophic fall if the plant is exposed to drought at the stalk-shooting stage, this fall being due to the distortion of the ear. In the earing phase, however, when the ear has been fully formed, the main cause of a sharp decrease in the number of grains is injury to floral organs, i. e. the anthers and

the stigma. If a drought occurs at a subsequent stage of development it does not affect the number of grains to any marked extent.

Now let us consider the influence of drought on absolute weight.

Table 3

Variations in the Absolute Weight of the Grain Due to Drought at Different Stages of Development

Varieties of soft and hard wheat	Abs. weight in grams with drought occurring during			Control
	tillering	at the moment when the grain begins to form	milky ripeness stage	
Soft — Erythrospermum 0841	33.6	16.4	24.8	35.7
Soft — Lutescens 062	24.7	19.1	21.4	30.3
Soft — Alborubrum 02225	27.5	16.6	21.9	30.5
Hard — Melanopus 069	27.6	17.7	23.1	32.9
Hard — Melanopus 01932	32.8	20.9	28.7	33.8
Hard — Candicans 02116	24.8	21.9	24.4	28.3

As shown in Table 3, if a drought occurs at the tillering stage a slight lowering of absolute weight is produced as compared with control. This is due to the fact that the plants exposed to drought at the tillering stage, are afforded long period of recovery. If a drought occurs after the grain has begun to form, the fall in weight is very sharp, and amounts to as much as 55% for certain varieties. At the stage of milky ripeness, there is also a reduction in absolute weight but a slighter one than at the beginning of grain formation. Consequently, a drought occurring at the earlier stages of development affects the reduction in absolute weight indirectly, through the weakening of the plant. But as soon as the grain has been formed the influence of drought on the absolute weight is a direct one, thus causing to appear what may be termed a second critical period (Tables 3, 4).

We shall now consider the total grain yield, which is the result of the addition of all its various elements.

The above table shows that the greatest reduction of the yield is observed if the plant is exposed to drought during the stalk-shooting—earing stages. As one gets away from the critical period, either towards tillering or towards milky ripeness, the fall in the yield is reduced.

It may be well to mention here that the statements of a number of writers([2],[3]) as to the stimulating effect of drought at the tillering stage, which is supposed to increase the yield, are not confirmed by our data. In our experiments all the varieties of wheat exposed to drought during the tillering period showed a decrease of yield, as compared with the control plants. The brief spurt ([4],[5]) of photosynthetic energy after wilting cannot make up for the harm caused to the plants by drought. Thus any drought, at whatever phase it might occur, is harmful, since it reduces the rate of development and depresses the plant. In order, therefore, to obtain the highest possible yield, the plants ought to be provided with optimal quantities of water throughout the vegetative period, a very good proof of which is afforded by the excellent «Stakhanovite» yield obtained by irrigation.

Table 4

Grain Yield of Wheats Exposed to Soil Drought at Different Stages of Development

Varieties of soft aud hard wheat	Grain yield in grams per vessel					
	Drought occurring during					
	tillering	stalk-shooting	earing	beginning of grain formation	stage of milky ripeness	Control
Soft { Erythrospermum 0841	5.98	1.03	3.55	2.69	6.0	8.98
Soft { Lutescens 062	3.98	0.87	1.12	2.80	5.24	8.18
Soft { Alborubrum 02225 . .	3.70	1.26	1.72	2.72	5.24	7.23
Hard { Melanopus 069	4.62	1.05	1.12	2.50	4.50	7.09
Hard { Melanopus 01932 . . .	4.52	0.21	0.86	3.11	4.28	5.43
Hard { Candicans 02116 . . .	3.90	0.24	2.38	2.30	3.8	5.30

As to the individual characteristics of the above varieties it may be mentioned that erythrospermum 0841 has proved to be the most prolific and drought-resistant of all the soft wheats, with droughts occurring at any phase of development, excepting of the stalk-shooting phase when alborubrum 02225 showed a higher yield. The lutescens 062 and alborubrum 02225 varieties are less prolific and drought-resistant than erythrospermum 0841 if the drought is very bad.

The hard wheats tested in this experiment have on the whole proved less prolific than the soft ones, the best in this respect among hard wheats being melanopus 069. With droughts occurring at the tillering or ripening stage, melanopus 01932 proved to be nearly as good as 069, but it was decidedly inferior to the latter with droughts occurring at the stalk-shooting or earing stage. Candicans 02116 differs from these two varieties in that it gives a higher yield if drought occurs at the earing stage.

The following conclusions may be drawn from the above data:

1. If a drought takes place at the tillering stage, the resulting poor yield-crop is due to the general depression of the plant.

2. If a drought occurs during the stalk-shooting period, the bad crop is due to the distortion of the ear; if at the earing stage, to injury to floral organs; the number of grains in the ear is reduced in either case, and this diminishes the grain yield.

3. If a drought takes place during the ripening of the grain, the bad crop is due to a reduction in absolute weight.

4. The injury caused to plants by droughts occurring at different stages of development is not always the same, hence, the relative importance of the main indices of drought resistance may change according to environment.

5. In determining the drought resistance of wheat varieties, account ought to be taken, amongst other characteristics, also of the number of grains in the ear, this being an important index of drought resistance.

Krasnokut Plant
Breeding Station

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PLANT PHYSIOLOGY

APPLE TREE PHYSIOLOGY IN RELATION TO SOIL CONDITIONS

By T. A. KRASNOSELSKAJA-MAXIMOVA, T. V. KULAGINA, K. I. ORLOVA, L. N. FILIMONOVA and N. V. ČUGREJEVA

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General suffering of fruit trees, particularly of apple-trees, is very often to be observed on separate sections of orchards in the Saratov district. This ultimately results in hollow building of the trees and renders them highly susceptible to infection with black cancer. At the same time other trees of similar age but on different sections of the same orchard grow prosperously and give a good yield. This suffering is apparently influenced by soil conditions. Soil analyses conducted by us in the experimental orchard of the Agricultural Institute showed that it largely consisted of washed out chernozem with solodized chernozem on individual spots. The physical structure of these sections of soil is distinguished by considerable density, the root systems frequently avoiding penetration into the main ground but follow the mole borings. Depth of root penetration is about 2.5 m. In the washed out chernozem the roots grow both in the main soil and along the mole borings, reaching here a depth of up to 3 m. The soils were analysed by horizons (K. I. Orlova) and some of the characteristic analyses are given in Table 1.

Table 1

Soil Characteristics, May 1936

Horizon in cm	pH		Dense residue		Hygrosc. moist.		Mineral part	
	Wash.	Solod.	Wash.	Solod.	Wash.	Solod.	Wash.	Solod.
35	7.0	6.6	0.1050	0.0860	3.2	3.1	0.01548	0.0345
65	6.7	6.4	0.0782	0.0495	3.2	2.9	0.01854	0.0291
85	6.6	6.3	0.0701	0.0723	3.1	2.9	0.01546	0.0572
135	6.5	6.4	0.0737	0.0440	3.0	2.8	0.01699	0.0267
170	6.5	6.4	0.0540	0.0300	2.5	2.3	0.01231	0.0253
205	6.5	6.3	0.0364	0.0420	2.5	2.3	0.03481	0.0381

Horizon in cm	Calcium		Sulphur		Chlorine	
	Wash.	Solod.	Wash.	Solod.	Wash.	Solod.
35	0.0001035	0.0006378	0.007388	0.01161	0.0006893	0.001031
65	0.001035	0.001118	0.007122	0.005537	0.0006870	0.01923
85	0.0005167	0.001363	0.002883	0.01719	0.001031	0.03439
135	0.0007224	0.0009025	0.002102	0.006970	0.004138	0.004112
170	0.0007196	0.0006656	0.001274	0.006032	0.002754	0.003422
205	0.001450	0.0005894	0.003925	0.008029	0.002748	0.003422

The microbiological soil analysis (K. I. Orlova) serves as an additional characteristic of the soil. Analyses conducted in May, 1936 showed that cellulose decomposition is analogous in both sections, namely, fairly strong in the upper horizons and either weaker or entirely absent in other horizons. There is likewise no disparity in the activity of the nitrogen fixative

Clostridium which in both soils is insignificant. The following disparities are to be observed in relation to the denitrificators: in the solodized soil in the two upper horizons (up to 34 and up to 60 cm) the process is very intensive (900 000 and 70 000 individuals per 1 g of soil), being far weaker in the washed out soil (80 000 and 40 000). The deeper horizons of the solodized section are marked by a sharp reduction in the number of denitrificators and, at a depth below 132 cm, they vanish completely. They are to be found in small numbers at lower depths in the washed out section, though their general quantity is far less than in the solodized section. Actinomycets are to be found in small quantities in both soils but distributed to a somewhat lower depth in the washed out soil (136 cm). In the washed out chernozem ammonification and nitrification bacteria as well as the nitrofixative *Azotobacter* are present as deep as 136 cm, and their number gradualy falls with the depth, in the solodized chernozem their number falls very sharply and deeper than 90 cm they are not to be found.

In order to get objective data on the extent of development of the trees on different soils we have made (N. V. Čugrejeva) an account of the foliage and have made some measurements.

Table 2

Pink-striped Anis Apple-tree No 3, 5 VII 1936; Washed Out Chernozem

Number of leaves on branch *A*	1 706
Their surface	3.26 m²
Number of branches resembling *A*	140
Approximate number of leaves on tree	240 000
Their approximate total surface	456 m²
Crown projection of tree	50 »
Height (of whole tree)	5.5 m
Weight of fresh leaves of whole tree	58 kg
Weight of air dry leaves of whole tree	25 »
Weight of absolute dry mass of leaves of whole tree	23 »
Water of the total leaf mass	35 »

Table 3

Velvet Anis Apple-tree No 8, 17 VII 1936, Solodized Chernozem

Number of leaves on branch *B*	437
Their surface	0.41 m²
Number of tree branches resembling *B*	40
Approximate number of leaves on tree	17 500
Their approximate total surface	16.5 m²
Crown projection of tree	13.4 »
Height (of whole tree)	3.7 m
Weight of fresh leaves of whole tree	2.7 kg
Weight of air dry leaves of whole tree	1.2 »
Weight of absolute dry mass of leaves of whole tree	1.1 »
Water of the total leaf mass	1.6 »

We have investigated these trees and found that the leaves of those from the washed out chernozem always have a higher ash content than the trees from the solodized chernozem, hence, the cause of suffering of the trees on the solodized chernozem is not to be sought in the accumulation of salts. Data are given in Table 4 (L. N. Filimonova). The total quantity of ash is expressed in percentage to the absolute dry substance. Tests were taken before dawn.

Table 4

Ash Content in the Leaves of the Anis Apple-tree on Two Soils

Soils	26 V	26 VI	15 VII	28 VIII
Washed out chernozem	7.0	9.0	10.0	12.2
Solodized chernozem	6.0	6.4	8.4	11.0

The capacity of the dry leaf mass to hygroscopically absorb water was determined (N. V. Čugrejeva). It appeared that the finely powdered leaves, dried to a constant weight, differ in their absorption of water when placed in a moist chamber, namely, the leaves of trees from the washed out chernozem during 8 h. 20 m. of the experiment nearly all the time absorbed water more rapidly than the leaves of trees from the solodized chernozem. Absorption of water is especially strong during the first 4 hours of the test. This absorption is, apparently, due to the swelling of the colloids of the leaf mass. Some differences are to be observed depending on the leaf exposure in the tree crown.

Table 5

Water Absorption by Dryed and Powdered Leaves of Trees from Different Soils, 9 VI 1936; 10 Leaves from Each Exposure in the Tree Crown

Soil	Expos. in the crown	Fresh weight g	Water in % to the abs. d.w.	Abs. dry weight g	Water absorption by dry powdered leaves in % of the weight on the beginning of each period					
					20 m.	20 m.	40 m.	60 m.	2 h.	4 h.
Washed out chernozem	Northeast	2.96	119.7	1.3474	0.481	0.435	0.831	1.582	3.481	3.111
	West	5.52	179.5	1.9734	0.312	0.278	0.590	1.024	2.654	4.762
	South	3.15	167.1	1.1784	0.401	0.473	0.805	1.125	2.545	6.488
Solodized chernozem	Northeast	4.77	177.2	1.7214	0.265	0.265	0.521	0.918	1.725	2.502
	West	4.65	179.6	1.6620	0.365	0.236	0.580	1.088	2.134	4.314
	South	4.47	196.4	1.5086	0.312	0.221	0.550	0.902	2.042	3.862

The behaviour of the stomata of the leaves of trees from different soils likewise differed. We found (N. V. Čugrejeva) that leaves stripped from branches of trees from solodized spot lost water far more rapidly when dried than leaves of the trees from the washed out chernozem. Under these conditions it was found that the stomata of the former are opened much wider than those of the latter.

Table 6

Waterloss of Isolated Leaves in Percentage of Their Weight at the Beginning of each Period

11 VI 1936

Soil	2 h.	2 h.	2 h.	2 h.
Washed out chernozem	10.8	7.9	8.0	11.2
Solodized chernozem	14.0	11.2	9.9	14.1

22 VII 1936

Soil	10 m.	10 m.	20 m.	10 m.	30 m.	1 h. 30 m.	1 h.
Washed out chernozem	2.6	1.6	2.6	1.1	2.3	5.6	9.7
Solodized chernozem	3.6	3.7	7.0	4.8	5.8	11.3	17.3

When dried, the leaves of trees from the solodized chernozem became considerably brown and determinations of the pH concentration of their pressed out sap has inevitably shown this to be higher than that of the sap of leaves of trees from the washed out chernozem (T. V. Kulagina).

Table 7

pH of the Leaf Sap

Soil	5 VIII	9 VIII	21 VIII
Washed out chernozem	7.93	5.69	5.79
Solodized chernozem	9.72	8.58	8.92

Determination of the chlorophyll content in the leaves likewise showed differences (T. V. Kulagina).

Table 8

Determinations of Chlorophyll in Milligrams per 1 g of Absolutely Dry Substance

Soil	16 V	17 V	17 V	22 V	5 VI	5 VII	29 VIII
Washed out chernozem	7.18	6.46	6.02	8.60	7.66	8.26	7.57
Solodized chernozem	5.39	4.68	4.54	5.37	5.87	7.65	5.79

Determination of the osmotic pressure of the leaf sap were also conducted, and, with but only one exception, it was always found to be higher under conditions of the washed out chernozem, though the differences usually were not great (T. V. Kulagina).

Table 9

Osmotic Pressure of the Leaves Sap (in Atmospheres)

Soil	31 V	11 VI	11 VII	13 VIII	29 VIII	28 IX
Washed out chernozem	21.14	18.40	9.27	23.54	22.60	23.10
Solodized chernozem	11.95	20.08	7.56	22.45	21.58	21.05

The low osmotic pressure registered on July 11th is explained by the heavy rain and the considerable fall in the air temperature.

The fermentative activity, namely the quantity of peroxydase, in the leaves of trees from the solodized chernozem was found to be nearly always higher than in those from the washed out chernozem (T. V. Kulagina).

Table 10

Activity of Peroxydase in Milligrams of Purplegallin per 1 g of Absolutely Dry Substance

Soil	16 VI	16 VIII	22 IX
Washed out chernozem	0.33	0.36	0.41
Solodized chernozem	0.66	0.35	0.52

All the data set forth above indicate that the trees growing on the two soils under examination differ in their physiological activities in several respects. We are not aware of whether these disparities are directly dependent on the soil conditions or whether they represent the result of the general change in vital processes under the influence of these conditions. Whatever the direct cause it is essential that we know namely what disturbances in the vital processes occur therefrom.

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ANATOMIE VÉGÉTALE

SUR QUELQUES PARTICULARITÉS DU SYSTÈME CONDUCTEUR DU PÉTIOLE DE LA RAMIE (*BOEHMERIA NIVEA* L.)

Par A. JACENKO-CHMELEVSKIJ (YATSENKO-KHMELEVSKY)

(Présenté par A. A. Richter, de l'Académie, le 31. VII. 1937)

Les feuilles de la Ramie possèdent trois nervures principales (une centrale et deux latérales). La nervure centrale porte un grand faisceau vasculaire, et chacune des deux latérales, deux petits faisceaux vasculaires. Des faisceaux principaux partent des nervures secondaires. Le fusionnement des nervures latérales avec la nervure principale s'accomplit au sommet du pétiole.

Le système conducteur du pétiole est aussi composé de cinq faisceaux vasculaires, dont trois (deux petits et un grand) passent dans la partie inférieure (dorsale) du pétiole et les deux autres dans la partie supérieure (ventrale). Le grand faisceau occupe dans le pétiole une position plus ou moins centrale et les quatre autres sont disposés aux bords du pétiole.

La trace foliaire qui entre dans la tige est composée de trois faisceaux (trois traces foliaires) et chaque faisceau s'unit avec le stèle par une lacune spéciale [1]. Une telle structure de la feuille et du pétiole permet de conclure que les trois traces foliaires de Ramie sont les traces des trois nervures principales de la feuille [1, 2].

Néanmoins, une étude plus détaillée de l'anatomie du pétiole de la Ramie prouve, qu'en réalité, l'ordre des choses est plus compliqué.

Nous avons étudié les régions du fusionnement du pétiole au limbe de la feuille et à la tige. Dans ce but nous avons préparé au microtome une série continue de coupes transversales du sommet et de la base du pétiole. L'examen de ces coupes a montré que l'union des nervures de la feuille commence par le rapprochement des masses parenchymateuses des nervures (il est à noter qu'une des nervures tarde presque toujours). À l'endroit du fusionnement la nervure centrale porte un solide faisceau en forme de fer à cheval (section transversale) et les nervures latérales portent chacune deux faisceaux, bien moindres que le faisceau de la nervure centrale.

Dans les premiers stades du rapprochement des nervures, le limbe de la feuille persiste encore, mais bientôt le parenchyme de la feuille perd ses chloroplastides et devient identique au parenchyme du pétiole. La lacune qui séparait le limbe des massifs des nervures, s'amoindrit et disparaît. Le fusionnement des nervures en pétiole est achevé. Dans cet état le pétiole porte cinq faisceaux, dont le central est le faisceau de la nervure centrale et les deux paires des faisceaux latéraux sont les faisceaux des nervures latérales. Désignons les deux faisceaux latéraux, disposés du côté ventral du pétiole.

comme les faisceaux latéraux supérieurs, et les deux autres—les faisceaux latéraux inférieurs. Presque simultanément avec le fusionnement des nervures, le faisceau central et les deux faisceaux latéraux inférieurs commencent à détacher des petits faisceaux. Quelques dixièmes de millimètre plus bas, ces petits faisceaux s'unissent en anastomoses qui ont une direction presque perpendiculaire aux faisceaux principaux. Les anastomoses unissent d'abord le faisceau central avec les deux faisceaux latéraux inférieurs et se dirigent ensuite vers les faisceaux latéraux supérieurs. Immédiatement après la disparition des anastomoses entre le faisceau central et les faisceaux latéraux inférieurs, tous ces faisceaux commencent à se fusionner. Le fusionnement s'achève très vite et alors le pétiole possède en coupe transversale un grand faisceau en forme de fer à cheval (qui conserve ordinairement les traces des faisceaux fusionnés), et du côté ventral, deux petits faisceaux latéraux (les faisceaux latéraux supérieurs) avec les anastomoses qui les unissent au faisceau central et aux deux faisceaux latéraux inférieurs.

Les coupes suivantes, prises un dixième de millimètre plus bas, montrent la rupture du grand faisceau central en trois faisceaux. Il est important de noter que les nouveaux faisceaux latéraux contiennent une part des vaisseaux du faisceau central. D'ailleurs, dans ces coupes on peut voir le fusionnement de la paire supérieure des faisceaux avec les anastomoses partant du faisceau central. A côté des faisceaux supérieurs on remarque des petits faisceaux composés de quelques vaisseaux ou même d'un vaisseau solitaire et qui courent le long du pétiole à une distance indéterminée. Le processus de l'organisation du pétiole est achevé. Un peu plus bas, les faisceaux se sépareront encore plus l'un de l'autre et occuperont la position qu'ils conservent, sauf quelques exceptions, tout le long du pétiole, jusqu'à ce qu'il se joint à la tige.

Examinons ce système de fusionnement des faisceaux au sommet du pétiole. Le résultat final du développement des cinq faisceaux des trois nervures est la formation des cinq faisceaux du pétiole. Mais ces derniers ne sont pas analogues aux cinq faisceaux des nervures de la feuille. En effet le faisceau de la nervure centrale se divise dans la partie apicale du pétiole et se fusionne avec les faisceaux latéraux inférieurs et, à l'aide des anastomoses, avec les faisceaux latéraux supérieurs. De toutes ces désagrégations et agrégations des faisceaux il en résulte que les éléments du faisceau central se distribuent parmi les cinq faisceaux du pétiole. Les paires des faisceaux latéraux supérieurs et inférieurs sont aussi unis entre elles par les anastomoses qui lient le faisceau central avec les faisceaux supérieurs. Néanmoins, il semble que la masse principale des vaisseaux des anastomoses fusionnant avec les faisceaux supérieurs est composée de vaisseaux du faisceau central.

Notons que tous ces fusionnements ont lieu dans une portion du pétiole mesurée, à peu près, par un millimètre (du moment de la fusion des nervures jusqu'à l'organisation finale du pétiole). Il est clair que grâce à des dimensions si petites de la partie apicale du pétiole (du «nœud»), il est indispensable, pour suivre la marche des faisceaux, d'avoir une série ininterrompue de sections de toute la portion du pétiole en question, faite au microtome.

Les faisceaux du pétiole se reconstituent de nouveau, près de la tige, à une distance variant de quelques millimètres jusqu'à un centimètre et même plus. Le premier stade de ce processus, c'est la désagrégation des faisceaux latéraux supérieurs et la fusion des petits fils de vaisseaux solitaires en faisceaux plus ou moins solides. Plus bas, tous les faisceaux désagrégés se réunissent en trois groupes, se dirigeant vers les trois faisceaux de la partie dorsale du pétiole (le faisceau central et les deux faisceaux latéraux inférieurs). Enfin, dans le voisinage immédiat de la tige, ces groupes de faisceaux désagrégés se réunissent avec les trois faisceaux de la partie

dorsale, et les trois faisceaux plus on moins solides, sortis de cette fusion, forment les trois traces foliaires de la Ramie.

Nous avons étudié cinq pétioles, pris des plantes différentes. Pour être sûr que les faits exposés plus haut caractérisent bien le pétiole de la Ramie général et ne sont pas dus au hasard, une expérience suivante a été faite. Au mois de mai 1937 trente feuilles de la Ramie ont été prises dans les plantations de la Section d'Anatomie et de la Physiologie de l'Institut Botanique de Tbilissi (Tiflis). Tous les pétioles ont été découpés de manière à séparer un des faisceaux (un des faisceaux latéraux supérieurs, un des faisceaux latéraux inférieurs ou le faisceau central). Ces pétioles ont été plongés dans la paraffine fondue, après quoi le faisceau isolé a été délivré de la paraffine. Les feuilles ont été placées dans une solution aqueuse de safranine et mises au soleil. Deux-trois heures après, les pétioles ont été analysés. Les premières sections ont été exécutées dans la partie basale du pétiole pour s'assurer que la solution du colorant n'a pas passé dans les faisceaux fermés par la paraffine. Une autre série de sections a été faite au sommet du pétiole, avant la divergeance des nervures, pour contrôler l'ascension de la safranine dans le faisceau étudié. La dernière série des coupes se faisait dans la feuille, à l'endroit où les nervures commencent seulement à se dégager du pétiole. L'expérience a démontré clairement que le passage de la safranine est en concordance complète avec le système du fusionnement des faisceaux dans le sommet du pétiole décrit ci-dessus.

Le système compliqué du passage des faisceaux vasculaires dans le pétiole est lié sans doute avec l'influence que la feuille exerce sur la formation de la tige. Certes, dans ce sens la feuille est plus active durant les premiers stades de sa formation, mais, comme il a été démontré par Alexandrov et ses collaborateurs (1), la feuille tout le long de son existence exerce une influence sur la formation des parties du cylindre central de la tige, liées anatomiquement avec la feuille (les traces foliaires). La nature chimique de ces impulsions est peu claire, mais, néanmoins, il est certain que le passage des agents de l'influence de la feuille sur la tige est localisé dans le système conducteur du pétiole. Le pétiole ne peut pas être considéré comme un organe passif de transmission de l'influence formative de la feuille sur la tige. L'analyse du système conducteur du pétiole démontre, au contraire, que dans ce dernier, les éléments du cylindre central—les faisceaux vasculaires—se reconstruisent selon un plan complexe. Comme il a été démontré plus haut, tout le sytème du passage des faisceaux dans le pétiole a pour but une répartition proportionnelle des éléments des cinq faisceaux des trois nervures de la feuille entre les trois faisceaux des traces foliaires. Nous avons vu, en effet, que le faisceau de la trace foliaire centrale contient des éléments du faisceau de la nervure centrale et des nervures latérales; les faisceaux des traces latérales contiennent, de même, les éléments du faisceau central et de tous les faisceaux latéraux. Notre étude indique qu'il ne peut être question des traces de nervures centrales ou latérales. Les faisceaux des trois traces foliaires de la Ramie, au point de vue de leurs relations avec les faisceaux de nervures de la feuille sont adéquats l'un à l'autre. Le sens de cette égalité n'est pas clair. Il est probable que ce système de passage des faisceaux a pour but de transmettre dans la tige les substances élaborées dans la feuille, d'une manière plus ou moins uniforme, ou, peut-être, garantir leur distribution ordinaire dans le cas des déchirures d'un des bords du limbe, cas assez fréquent dans la plante étudiée.

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MECHANIK DER EMBRYONALENTWICKLUNG

ZUR FRAGE NACH DEM MECHANISMUS DER WIEDERHERSTELLUNG DER KRISTALLINSE BEI AMPHIBIEN

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(Vorgelegt von A. A. Richter, Mitglied der Akademie, d. 25. VII. 1937)

1. Einleitung und Fragestellung

Colucci (4) war der erste, der die Wiederherstellung der Kristallinse nach Entfernung bei Tritonen aus dem oberen Rand der Regenbogenhaut beobachtete. Diese Erscheinung (die sogenannte «Wolffsche Linsenregeneration») ist nach den Arbeiten von Wolff(10) eine bekannte Tatsache. Eine grosse Anzahl von Arbeiten über diese Frage war in der ersten Zeit der Aufklärung der morphologischen Seite dieses Prozesses, der Feststellung und Beschreibung dieser Erscheinung bei verschiedenen Tierarten und Tierklassen gewidmet [Röthig, 1898; Fischel, 1898; Koch, 1897; Müller, 1896; Barfurth, 1902; Dragendorff, 1903; Pardo, 1906; Grochmalicki 1908 und viele andere).

Durch die Arbeiten von Spemann (9), Filatow (5,6), und einzelne Beobachtungen von Bell (1905), King (1905), Wachs [1920(11)], Beckwich (1927), Pasquini [1927(7)], Adelmann (1928), Gasteeva (1935) u. andere wurde festgestellt, dass auch bei frühen Embryonalstadien die Linse sich aus dem Rand des Augenbechers bilden kann, wenn die ektodermal entstandene Linse entfernt wird.

Nachdem der Prozess von der beschreibend-morphologischen Seite genügend aufgeklärt war, entstand das Problem einer kausalen Analyse der Erscheinung. Das Problem besteht in folgendem: in erster Reihe müssen die Faktoren festgestellt werden, unter deren Einwirkung die Wiederherstellung der Kristallinse, d. h. ihre Regeneration oder, richtiger gesagt, der Prozess der «Morpholaxis»—Umschmelzung differenzierten Materials—des Regenbogenhautrandes in der Kristallinse vor sich geht.

Zweitens, muss aufgeklärt werden, ob der obere Rand der Iris besondere linsebildende Eigenschaften besitzt. Letzteres führt zur tieferen Analyse des Wiederherstellungsprozesses der Kristallinse. Im Falle einer klaren Lösung dieser Frage lässt es sich auch entsche den, ob der Prozess der Wiederherstellung der Kristallinse eine Induktion ist (ähnlich der Linseninduktion aus Ektoderm bei frühen Entwicklungsstadien) oder hier eine Regulation stattfindet, welche durch die innere Potenz der Iriszellen bestimmt ist.

Zur Aufklärung dieser Fragen wurden verschiedene Versuche an verschiedenen Amphibienarten unternommen (*Triton cristatus*, *T. taeniatus*, *Rana esculenta*, *R. temporaria*, *Bombina bombina*, *Pelobates fuscus*, *Bufo bufo*).

Die Arbeit ist noch nicht abgeschlossen, dennoch erlauben die Resultate, über die wir jetzt schon verfügen, einige Schlussfolgerungen.

2. Versuchsresultate

Zwecks Lösung der ersten Frage,—über das Vorhandensein morphogéner Einwirkungen im Auge, sowohl bei Larven (Kaulquappen), als auch bei erwachsenen Amphibien,—war es notwendig, mit der Netzhaut solches Material in Berührung zu bringen, von dem wir im voraus wissen, das es sich bei Vorhandensein von morphogener Einwirkung in eine Linse umbildet. Als solches Material dient bekanntlich die Epithelhaut bei frühen Embryonalstadien einiger Amphibien.

Die Versuche wurden in folgenden Richtungen ausgeführt.

Während verschiedener Entwicklungsstadien bei *Anura* wurde die Kristallinse entfernt (erste Versuchsgruppe), um festzustellen, wie lange die Kristallinse fähig zur Regeneration ist.

Gleichzeitig mit diesen Versuchen, in denselben Stadien, nach Entfernung der Kristallinse, wurde an deren Stelle Rumpfepithel implantiert, welches bei frühen Keime genommen wurde, um aufzuklären, ob von Seiten des Auges morphogene Einwirkungen erfolgen (zweite Versuchsgruppe).

Solche Versuche wurden auch an *Urodela* angestellt.

Bei der dritten Versuchsgruppe wurde in denselben Entwicklungsstadien (wie bei *Anura* so auch bei *Urodela*) das Epithel implantiert, aber die Kristallinse nicht entfernt. Diese Versuche sollten aufklären, ob das Vorhandensein der Kristallinse keinen Einfluss auf die Äusserung des morphogenen linsebildenden Einflusses des Auges hat ([11]).

Wir werden hier keine ausführliche Analyse der Resultate jeder Versuchsserie anführen, sondern nur die allgemeinen Schlussfolgerungen derselben.

Die Resultate unserer Versuche erlauben die Behauptung, dass das Auge der Amphibien, sowohl der Larven, als auch der erwachsenen Tiere, morphogenen Einfluss besitzt, unter dessen Einwirkung das Epithel früherer Keimstadien, welches in die hintere Augenkammer implantiert wurde, sich in Linse umbildet. Bei der Durchsicht der Präparate erscheint es möglich, die Vermutung zu äussern, dass die morphogenen Eigenschaften des Auges der Larven (Kaulquappen) und der erwachsenen Formen fast dieselben linsebildenden Wirkungen haben wie der Augenkeim des Embryos des frühen Stadiums, wo in der Norm der Prozess der Linseformierung vor sich geht. Davon spricht schon der Umstand, dass die Geschwindigkeit der Linsebildung aus implantiertem Material (es liegt Grund vor anzunehmen, dass sie sich nämlich aus dem Implantat bildet), wie auch die Geschwindigkeit der Differenzierung fast dieselben sind, wie bei der normalen Entwicklung. Zur Illustrierung führen wir einige Beispiele an.

Nr. *R. t.* III. 26, operiert am 13. V, fixiert am 19. V. 1937. Rezipient *Rana temporaria*, Stadium—26 mm Länge (vor der Operation). Hintere Extremitäten dreigliederig. Spender *Rana esculenta*, — frühes Schwanzknospenstadium.

Die Kristallinse wurde entfernt, und an ihre Stelle wurde ein Stück Rumpfepithel des Embryos implantiert. An den Schnitten ist zu sehen, dass das Implantat in der inneren Augenkammer liegt, und aus dem Teil, der dem Rand der Netzhaut anliegt, bildet sich eine Linse. Sie ist schon klar differenziert in Fasern und Epithel. Der Teil des Implantats, welcher nach aussen liegt, ist ein formloses Epithelstück, mit welchem die sich bildende Linse in stetiger Verbindung steht.

Nr. *R. t.* IV. 37, operiert am 25. V, fixiert am 5. VI. 1937. Rezipient *R. temporaria*, 43 mm Länge (vor der Operation). Metamorphosenstadium. Hintere Extremitäten vollständig entwickelt. Spender *R. esculenta*, frühes Schwanzknospenstadium.

Bei der Implantation des Rumpfepithels wurde die Kristallinse nicht entfernt. Das ganze Implantat hat sich in eine Linse umgewandelt, welche in der inneren Augenkammer liegt zwischen der normalen Kristallinse und dem Boden des Augenbechers. Die Linse ist vollständig differenziert, und ist, nach den vorhandenen Mitosen zu urteilen, im Wachstum begriffen, wodurch die normale Kristallinse in die vordere Augenkammer gestossen wird, nachdem sie ihre normale Lage verloren hat.

Nr. *B. b.* XXIV 44, operiert am 20. V, fixiert am 20. V. 1937. Rezipient *Bombina bombina*, erwachsenes geschlechtsreifes Individuum. Spender *R. esculenta*; frühes Schwanzknospenstadium. Operation: die Kristallinse des Rezipienten wurde entfernt, und in die innere Augenkammer wurde ein grosses Epithelstück implantiert.

Auf den Schnitten ist zu sehen, dass das eingelagerte Implantat aus zwei miteinander verbundenen Stücken besteht. Am Ende des einen Stückes bildet sich eine Linse. Die Linse ist vollständig differenziert in Fasern und Epithel, steht aber noch mit seinem äusseren Ende in Verbindung mit der übrigen Masse des implantierten Epithels, welches als dünne Schicht vor der Pupille liegt.

Es ist interessant zu bemerken, dass auch in diesem Falle (wie in vielen anderen) die Linse sich aus dem Gebiet des Implantats entwickelt, welches der Netzhaut anliegt. Dies gibt Grund anzunehmen, dass wenn sich die Linse während der Embryonalstadien aus Ektoderm, oder während späterer Stadien aus dem Rand des Bechers bildet, bei Entfernung der normalen Linse die Hauptrolle als Induktor, d. h. als Quelle der morphogenen Einwirkungen der Netzhaut zukommt. Diesen Schluss bestätigen auch noch andere Versuche.

Bei vollständiger Entfernung der Netzhaut (und auch der Kristallinse), wie bei *Anura*, so auch bei *Urodela*, wird keine Wiederherstellung der Kristallinse aus dem Irisrand beobachtet. Auch in den Fällen, wo man mit der Kristallinse auch die Netzhaut entfernt, wird das implantierte Epithel in eine Linse nicht umgebildet.

Es muss noch bemerkt werden, dass in der ersten Versuchsgruppe, wo die Kristallinse entfernt wurde, bei den Kaulquappen von *Anura*, welche zu derselben Zeit operiert und fixiert wurden wie die in den oben angeführten Serien, nur bei zwei Exemplaren (entsprechend der Serie III, 26 mm Länge) am oberen Rande der Iris eine Aufhellung und Verdickung, was der Anfang der Bildung einer neuen Kristallinse ist, bemerkt wurden. In den anderen Serien konnten keine Merkmale dieses Prozesses festgestellt werden.

3. Kurze Bemerkungen über die erhaltenen Resultate

Filatow ([5],[6]) hat schon darauf hingewiesen, dass wahrscheinlich die Entstehung der Linse aus dem Augenbecherrand unter dem Einfluss der Induktionseinwirkungen geschieht, welche aus dem Boden des Augenbechers stammen. Unsere Versuche erlauben zu behaupten, dass das Auge (wahrscheinlich die Netzschicht) während der ganzen Periode der Ontogenese die Fähigkeit zu morphogenen linsebildenden Einwirkungen beibehält. Eine solche Auffassung widerspricht den Schlussfolgerungen von Manuilowa([2]), die behauptet, dass die Determinationseinwirkungen des Augenbechers auf das Epithel zum Schluss seiner Invaginationsperiode aufhören. Die Versuche dieses Autors gründen sich auf Angaben, welche durch Transplantation des Augenbechers unter das Rumpfepithel und umgekehrt des Epithels auf den Augenbecher erhalten wurden, was für die Lösung dieser Frage nicht genau genug ist.

Ein Teil, vielleicht derselben morphogenen Einwirkungen, entfällt wahrscheinlich auf die Schaffung der «permanenten Induktion» bei der Morphogenese der Hornhautschicht (1).

Dank dem Vorhandensein dieser Einwirkungen ist das Embryonalmaterial, welches in das Augensystem gebracht wird, wahrscheinlich fähig sich in eine Kristallinse oder kristallinseähnliche Form umzubilden. Letzteres wurde z. B. von Törö (1931, 1934) beobachtet, in dem er das Material aus Gewebekulturen des Küchleins in das Auge desselben brachte.

Wahrscheinlich kommt die Wiederherstellung der Kristallinse aus dem oberen Rand der Iris mit der Anteilnahme dieser Induktionseinwirkungen, welche aus der Regenbogenhaut ausgehen, vor; jedenfalls hat W. W. Popoff in seinen noch nicht veröffentlichten Versuchen festgestellt, dass der Rand, und zwar der ganze Rand, der Anuralarven eine Linse geben kann, wenn er als kleines Stückchen in den Augenbecher des Embryos transplantiert wird.

Diese Tatsachen und die Angaben von Pasquini (7) über die Bildung der Kristallinse aus dem unteren Irisrand bei den Kaulquappen nach der Entfernung der typisch gebildeten Kristallinse scheinen die höchst interessante, aber zu sehr spekulative Hypothese von Schimkewitsch experimentell nicht zu bestätigen. In dieser Beziehung ist Colucci (4) der Tatsache viel näher als einige andere Autoren (Wolff u. andere), da er bei der Beurteilung seiner Versuche besonders den Umstand betönt, dass die Induktion der Kristallinse während der Embryonalentwicklung und die Regeneration im Prinzip Erscheinungen gleicher Ordnung sind.

Nachdem das Vorhandensein morphogener Induktionen im Auge der Amphibien sicher für die ganze Periode der Ontogenese erwiesen sein wird, wird es für die weitere Arbeit erforderlich sein, genau die Frage über die linsebildenden Eigenschaften der verschiedenen Iristeile und über den Einfluss dieser Eigenschaften auf die Lokalisation der Stellen, wo die sekundäre Kristallinse entstehet, zu klären.

Nach der Aufklärung dieser Frage kommen wir der Lösung der Problems der Wiederherstellung der Kristallinse bedeutend näher.

Die positiven Resultate der Methode der Implantation in das Innere des Auges vom Embryonalmaterial, welche von Popoff für die Amphibien ausgearbeitet wurde (1), gibt uns die Möglichkeit, zu Untersuchungen des Problems der Determinationszusammenhänge auch in dem sich entwickelnden Auge der Säugetiere überzugehen.

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